RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED
ROADMASTER AND FOREMAN
BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK
Published by THE RAILWAY LIST COMPANY

WILLIAM E. MAGRAW, Pres. and Treas.
CHAS. S. MYERS, Vice-Pres. — LYNDON F. WILSON, Managing Editor
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Office of Publication: Manhattan Building, Chicago
Telephone, Harrison 4948
Eastern Office: 50 Church Street, New York
Telephone, Cortlandt 5765
Central Office: 403 House Bldg., Pittsburg

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.

In remitting, make all checks payable to the Railway List Company.

Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

This Publication has the largest paid circulation of any railway journal in the Maintenance of Way field.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series, Vol. 7
Old Series, Vol. 26 — Chicago, September, 1911 — No. 9

CONTENTS.

Editorial
Sand Sidings....401
Service....401
Cost Records....401
Railway Associations....402
Railway Ties of Concrete and Asbestos....402
Cement Industry in 1910....402
Track Elevation in Chicago....403
Concrete Pole Line....407
Sand Sidings....408
Wood Preservation....412
Concrete in Railway Construction....414
The Signal Department....424
Signal Standards No. 21, the Northern Pacific....424
Alternating Current Signaling Apparatus Chemnitz-Hilbersdorf Sorting Yard, Germany....424
Substitutes for Wood Trunking for Railway Signal Conduits....426
The Maintenance of Way Department....428
Relation of Track Fastenings to Creosoted Ties....429
Screw Spikes....430
Track Work....431
Glossary of Track Terms....432
Personals....436
Railway Construction....423-436
With the Manufacturers....437
New Literature....437
Crucible Cast Steel Shovels....437
Carbo Steel Posts....438
Bartley Nut Locks for Track Bolts....439
Industrial Notes....439
Railway Patents....440

Sand Sidings

ONE WRITER has said "the location of derails on the top of high embankments has the appearance of inviting disaster."

Even on tracks elevated above city streets we find derails located in places where a train is liable to be precipitated down into the street below, endangering not only the lives of passengers, but also the lives of pedestrians.

Derails are located in such places in accordance with the standards of the railway. Standards are undoubtedly necessary, and their use has greatly simplified the design and installation of many engineering structures. However, the use of a fixed standard under all and varying conditions is not in every case sound policy.

On another page a description is given of the use of sand sidings as a substitute for derails; this device is used in several countries in Europe. The efficiency of these sand sidings seems pretty thoroughly proven, for they have been in use for many years, the first being installed in 1895. Like improvements along many other lines, the sand siding is a more expensive structure than a derail. It also would probably require more maintenance, especially in the winter time. Its use would on this account be restricted to districts of maximum danger to the train if derailed onto the ties. The cost of such a siding would, however, be greatly overbalanced by the destruction of property which would likely occur if a train was derailed over a high embankment, to say nothing of the cost in lives lost, the value of which cannot be expressed on a money basis.

Service.

THE FOLLOWING is an extract from a paper entitled "Trade Paper Service," by Wesley A. Stanger, in *Advertising and Selling.*

> "The beginning of service in a trade paper that expects success must come in its reading pages. It must be published for the subscriber and must be edited by the editor, and the editor must know his business or else get out and let some one have his chair who does know his business. The trade paper that is edited for the man who pays his dollar is the paper that will get the business, and nothing can stop it. When the publisher prints a paper that the subscribers want to read and do read, and which represents them and their point of view, he is presenting something to the advertiser that is so valuable that its value cannot be computed by the rates on the back of the contract blank. To the advertiser, a medium of this kind is 24 karat fine, and whether he adveritses in it or not he pays for the advertising, and when he pays for it he might as well get it. If he doesn't run copy, he pays for it in business he loses to the fellow who does, and if he does use it he pays for it like any other necessity and gets big value in return. Service to the subscriber is and should be the primal consideration."

The interests of the advertiser must be taken care of, but many advertisers lose sight of the fact that the trade paper in serving the subscriber is serving the advertiser. Further service is due the advertiser and is given him. The advertising pages of a paper add to its value to the subscriber, bring before him the newest developments of progressive manufacturers, and aid in his information as to the best methods and implements to be used in the accomplishment of his problems.

Cost Records.

THE IMPORTANCE of having railway cost records that are reliable has been recognized for a good many years. That such records have not been carefully kept is shown by

an instance cited by F. J. Angier who kept a record of ties for the C., B. & Q. R. R., for ten years. On one division the records showed that in this period 435,000 ties had been put in the track, but only 5 ties had been removed.

Speaking on the subject of cost records, Mr. Sanford E. Thompson, M. Am. Soc. C. E., says:

"Besides being of use as a preliminary step toward the introduction of scientific management, cost keeping, that is, cost determination of work in progress, is of value to the engineer for making up estimates and checking the work of the builder, and to the builder in bidding on subsequent contracts and keeping track of the cost of the work as it progresses from day to day. In construction work based on the principle of cost-plus-a-fixed sum, and other similar systems, the accurate recording of detail costs on different parts of the work is absolutely essential for submitting the accounts to the owners.

"To accomplish any of these aims, the cost records must be accurate enough to serve:

"(1) As records for estimating costs of subsequent jobs.

"(2) For immediate use.

"(a) To determine whether the builder is making or losing money.

"(b) To fix any point of loss or of too small profit.

"(c) As an incentive to the foreman and workmen.

"As generally practised, cost keeping is so approximate and inaccurate as to be of comparatively little value for any of these purposes."

The question is discussed from the viewpoint of the contractor, but many of the points made in favor of accurate cost records will apply to railway records of various kinds. In addition there is the added advantage of direct annual unit cost comparisons of various kinds of material. At the present time data on the comparative life of ties of various woods, treated by different preservative processes, would be of great value. The reliability of much of the data along this line is seriously questioned.

Railway Associations.

THERE IS SUCH a large number of Railway Associations that it might seem as if these societies were liable to encroach on the business and affairs of each other. It is true that the questions to be considered by a number of these associations seem very closely allied. However, inspection will show that the subjects are attacked by each association in a different manner and possibly from an entirely different standpoint.

A great many times the discussion on a committee report brings out information as valuable or more valuable than the report itself. Discussion also increases the interest in meetings, and many times stimulates other members to participate, giving their experiences and opinions, which would not otherwise be obtained. In fact, free discussion is absolutely necessary for the success of these associations whose object is the spread of knowledge, and where there is no tangible reward. A man who will speak freely in a gathering of men who occupy positions of no higher importance than his own, will many times feel backward about airing his opinions before men who hold superior positions. And many times the information which would be withheld in this way, is information which is valuable and needed. Each society has its own function to fulfill, and in arriving at important conclusions, the pertinent information to be obtained from any association should not be overlooked.

RAILWAY TIES OF REINFORCED CONCRETE AND ASBESTOS.

A new reinforced concrete railway tie is being tested on the Bavarian railways, which, it is claimed, combines the elasticity of wood with the durability of steel and concrete. This tie is made of asbestos fibres soaked in water and saturated with pure cement. The mixture after complete saturation with water forms a soft tenacious mass which does not permit tamping or ramming as concrete does, but when hardened has two-thirds of the breaking strength of concrete. After setting it can be drilled, nailed and hammered like wood and retains its hold upon other materials better than wood. The concrete consists of 1 part cement, 1 part rubble and 2 parts gravel sand. The asbestos is used only below the actual seat of the rails. The ties are 8.9 ft. long, 8.8 in. wide and 7 in. thick, reinforced with 0.3 inch diameter steel rods.

The steel rods, which are for tensile reinforcement, are imbedded in the lower part of the tie, which is of concrete, and the asbestos is placed on top of this. This lessens the cost of the tie, as the asbestos is rather expensive. The cost is $1.50 to $1.75 per tie. The weight is about three times that of the wooden tie. The setting of the cement and asbestos is much slower than that of concrete and is accompanied by formation of heat. Hydrates of lime are formed in the process, as asbestos (calcium-magnesium silicate) has only a little silicic acid due to impurities. The excess of lime in the cement (25 per cent) is also changed to hydrate of lime with formation of heat. Whether the ties will meet the requirements of the expected wear and tear is still a matter of doubt, as they have only been used 5 months so far, but they have shown no defects within this time.—*Zement and Beton.*

CEMENT INDUSTRY IN 1910.

An Increase of Ten Million Barrels Over 1909 Shown by Figures of the U. S. Geological Survey.

The statistics of cement production in 1910, as reported by Ernest F. Burchard, of the United States Geological Survey, indicate that the cement industry ranks within the first eight extractive industries in the United States, the value of the cement produced being exceeded only by the value of the coal, pig iron, petroleum and gas, clay products, copper and stone.

The total quantity of Portland, natural, and puzzolan cements produced in the United States during 1910 was 76,934,675 bbls., valued at $68,052,771. Compared with 1909, when the production was 66,689,715 bbls., valued at $53,610,563, the year 1910 showed an increase of 10,244,960 bbls., or 15.3 per cent. in quantity, and of $14,442,208, or 26.9 per cent in value. The increase in quantity is one of the largest ever recorded.

It has been stated that the durability of the old cements—for instance, those of the Romans—is due to a low proportion of soluble silicates and a low lime content—under 50 per cent.—and that most modern high-lime cements are deficient in resisting power when exposed to waters containing dissolved alkalies and sulphates. In America a company has begun the manufacture of a cement which it is claimed will resist alkalies and sulphates by virtue of a low lime content and an excess of silica, using limestone, shale, and blast-furnace slag as raw materials.

Track Elevation in Chicago

Great improvements are being made in nearly every kind of railway construction. More money is being expended to get better results, and in many cases the best is proving none too good. In the past it has frequently been the policy to use the cheapest material and the cheapest methods for obtaining results which would serve the purpose. Many times that which would best serve the purpose was discarded for methods which would reduce the first cost. A decrease in first cost may soon be eaten up by increased operating or maintenance charges. There is also a liability of damage suits from poor construction. We find many improvements in track elevation work, i. e., in raising tracks above city streets, among which are the following:

(1) Improvements in methods of doing work.
(2) Improvements in equipment.
(3) Improvements in architectural appearance.
(4) Improvements in structures.

The first method of elevating track was simply a process of raising with track jacks in the usual manner, giving the tracks a number of lifts, each of a maximum height which the filling at hand allowed. If one lift of the jacks is not sufficient to use the material at hand, a second set of jacks may be used. After the first jacks have been run up as high as they will go, the head of the second jack may be set under the rail or even under a tie. The tampers are not delayed by this process, but can be filling in under the tie to be tamped. This method gives a high lift with one operation, but a large number of jacks are required; it is practical and still used in elevating a single or isolated track.

When a track cannot be raised to subgrade with one operation, or enough filling would not be available, a saving can be effected by raising as high as the material will allow, keeping the track approximately level, and wasting no time in getting the track smooth. Little tamping should be done, but filling should be shoveled in and leveled off under the tie ends. The idea is to make the track just safe enough for dirt trains, with the minimum labor. In cases where the filling is clay or dirt, some care must be exercised, as such material when wet would not hold up the track. Much labor is saved if, in this method, the centers are filled in by automatic center dump cars.

In places where there are a number of approximately parallel tracks close together, the following method has superseded the other to a great extent: A track is put out of service, and before any filling is unloaded, a raising gang tips up one side of the track as high as possible, generally using two sets of jacks as described above, propping it in this position with timbers three or four feet long, made from discarded track ties or timbers useless for other purposes; several trains of filling are then run in on the track next to it and the material is unloaded and runs under the track which has been tilted. As much filling is unloaded as is possible without burying the tracks. The raising gang then brings up the opposite side of the tilted track approximately level. This side is then filled in and later tamped up safe for dirt trains. Care must be exercised in this method to prevent burying of the unloading tracks, either from too much dirt being unloaded, or because filling is shoveled off and not thrown out away from the loaded cars. In a large yard a number of alternate tracks may be handled simultaneously, giving plenty of track room for unloading material.

The same operation is then used to bring up the tracks which were first used for unloading. These may be put up much higher, however, if both adjoining tracks have been elevated. The operation of raising and propping up is continued until the tracks are the desired height. This method has the following advantages over the first method:

(1) A greater number of trains can be spotted and unloaded on a track before it is necessary to interrupt the work to raise it.

(2) Less moving about of laborers, with corresponding greater results per man.

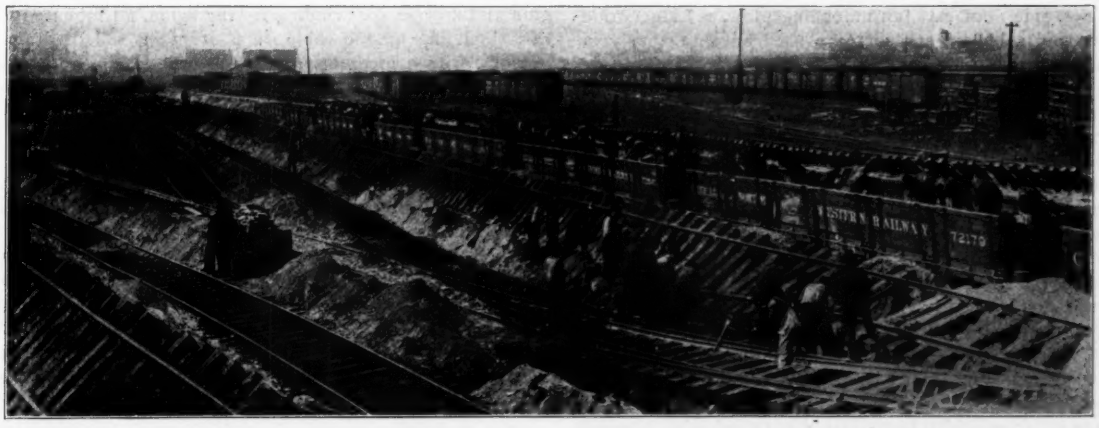
(3) Great reduction in the number of lifts necessary to put a track to grade.

(4) Great reduction in the amount of tamping.

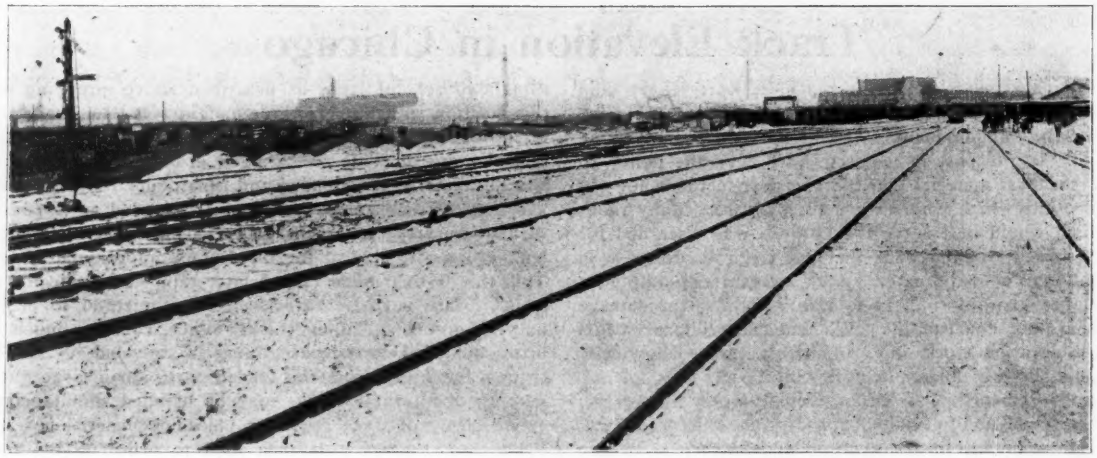
In following this method care should be taken not to bury any track, as subsequent raising becomes very expensive. Digging jack holes for a buried track is expensive on account of the greater depth and the sliding in of material. Raising is more difficult because of the increased load on the jack, and furthermore, a great number of ties are liable to be pulled off of the rails and left buried. When tilting tracks up, large gangs and 12 to 16 jacks should be used to obtain the best results.

The photograph shown herewith illustrates the "step method" of elevating. The higher track has received two or three lifts, the intermediate track has received only one lift, while the tracks in the foreground are at the original grade.

A method used for making fills on a new line and which has been adopted in track elevation work, is to build a temporary pile trestle (to be left in the fill) as cheaply as possible and do the filling from this trestle. An efficient way to



Elevating a Large Yard.



View of Yard Shown on Preceding Page, After Completion.

handle filling on one of these trestles is to use bottom dump cars, which require only the release of the automatic device to unload the material. When the fill gets up to the bottom of the ties, side door cars, an unloading plow, a Lidgerwood unloader and a ballast spreader are used advantageously in making the grades for the two adjoining tracks. The old tracks are torn up and loaded when following this method. After the filling has been spread out far enough, another track can be constructed on the grade and filling can be done from that track; or a temporary track may be constructed and lined over continuously as the grade widens; on the completed part new permanent track may then be laid.

A rather novel method has been used by the C. & N.-W. Ry. After a grade has been constructed the old track below is dragged up the slope onto the new grade by a derrick. An attempt was first made to bring this track up as a whole. This proved unfeasible, for rails and angle bars were badly bent. The method which proved successful was to disconnect the angle bars and drag up the track one rail section at a time.

In track elevation, where the sections between street subways are short, an unloading plow is not used with as much advantage as where a long, unbroken stretch of fill is to be made. In elevating a long yard, however, there is an advantage in this method, providing a Lidgerwood unloader is used to draw in and wind up the cable. The old method of unloading a train with a plow was to anchor the train (by setting the brakes and blocking the wheels), hitch a long cable to the plow and pull it over the cars by hitching the cable to the engine, which then moved away from the cars.

The Lidgerwood unloader consists of a stationary engine and a drum for winding up the cable, all mounted on a car. Winding up the cable on a drum instead of dragging it along with a locomotive, has the following advantages:

(1) Only one-half the track room, or just room enough to spot the train, is necessary, because the cable winds up instead of being dragged bodily the length of the train.

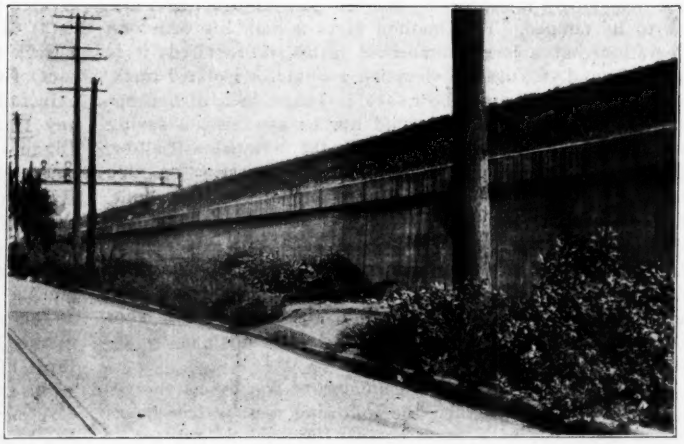
(2) Cars do not need to be so securely anchored, as the unloading car has a tendency to move in an opposite direction to the loaded cars, and thus the whole train is easily kept stationary.

(3) By use of low gearing a higher and more uniform power is developed. In case the plow is stopped by heavy material when unloading with locomotive power, the engine must take some slack and start the plow with a jerk. This will frequently break the cable, causing expense and delay. The drum winding apparatus will not be stopped by any ordinary obstruction.

(4) A slower and uniform method is given by the drum unloader. A locomotive dragging a plow, in order to prevent the plow sticking, frequently uses too high speed. If a large obstruction is met with, the plow is liable to jump off the cars before the engine can be stopped.

In former years it was considered necessary to erect false work for all of the steel bridges over streets. A great saving

Method of Raising Tracks.



Plain Wall Made Attractive By Neat Form Work, and Grassy Slope Above.

Placing Steel Direct, Without Temporary False Work.

in piles and pile driving is now effected in some cases by immediately putting the permanent steel work in place with a derrick, and without having any temporary structure.

The use of derricks and of all kinds of machinery has increased. A notable use of light derricks with long booms is for conveying concrete from the mixer and dumping it directly into the wall forms. The derrick is spotted on the same track and facing the track concrete mixer. A day's work can be accomplished with one spot, unless the wall is very low and requires a small yardage of concrete per running foot.

In addition to handling bridge caps, stringers, ties and rails in building temporary trestles, derricks are also used later in recovering the stringers and sometimes caps from a filled-in trestle. The track is removed and holes are dug so that chains may be passed around the timbers, and then the chains are caught up by the derrick hook. Other power devices are coming into use, though perhaps more slowly in track elevating than in other construction. The density of traffic, lack of track room and right of way, and danger to passing trains, of course, somewhat restricts the use of power equipment. However, it is advisable with the present scarcity and general low quality and quantity of labor obtainable, to substitute, wherever possible, power for hand labor.

The immensity of track elevation projects, together with the variety of problems encountered, has led to higher organization of the forces. Authority and responsibility are centralized to prevent interference among employes, as much as possible, and the duties, responsibility and authority of each department are sharply defined.

By centralization of authority operations are made to follow more nearly in the most advantageous order. At one time sewers and manholes were entirely neglected until the job was near completion. Excavation then had to be carried through the newly filled-in loose material, which had to be carefully sheeted to avoid caving. This method required expensive excavating. It is now customary to put in sewers and build up manholes (a partial section at a time if necessary), while the filling is being put in. In this way the entire cost of excavation is saved.

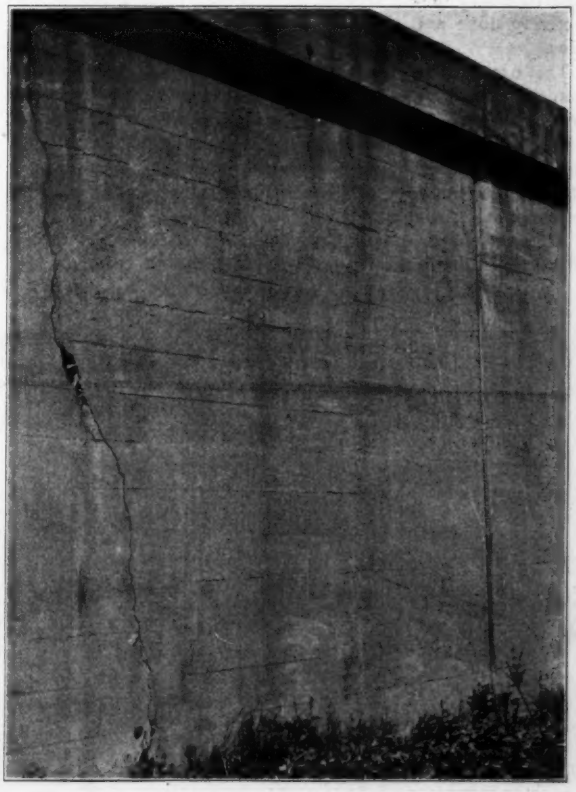
The improvements in cars for handling filling have been marked. Years ago the flat car, with or without side boards, was considered the best for handling earth or ballast. As the traffic increased, more powerful locomotives have come into use. With this came a demand for larger ballast cars along with the demand for freight cars of greater capacity. This demand first led to the use of the ordinary coal car or gondola, but unloading these cars is expensive, as all the material must be lifted over the side. The car with swinging side doors is a great improvement on the ordinary gondola. These cars with the end doors removed and provided with aprons, are unloaded advantageously with the plow.

Recently concrete retaining walls and bridge piers and abutments have almost entirely superseded masonry. Concrete retaining walls are susceptible of an attractive architectural design, and can easily be made much superior to masonry walls in appearance. In addition to being sightlier, the use of concrete does away with the stone yard with its crane and crew of laborers. Concrete walls are constructed much faster and there is not the necessity for skilled labor such as is required in masonry work.

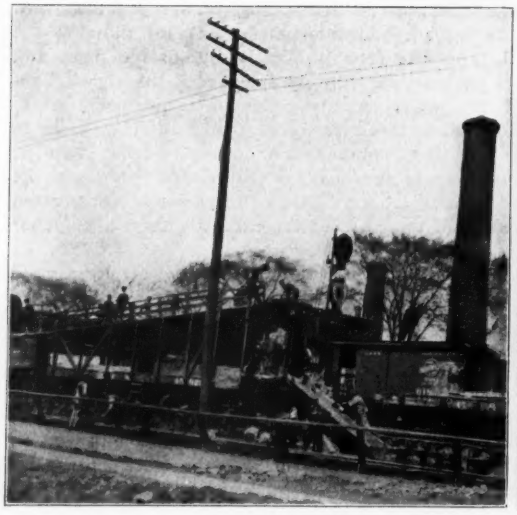
The forms constructed for concrete work were for a good while made without much regard for the appearance of the finished wall. Expansion joints were put in at standard distances without regard to the joints in the forms. A great improvement in the looks was obtained by making expansion joints to fit the form joints. For instance, if the boards used in the forms were sixteen feet long, an expansion joint was made every sixteen feet. If this is not done with wooden forms, the wet concrete will run into the cracks, leaving a vertical ridge on the face of the wall which is plainly discernible. An excellent artistic effect has been secured by the use of panels. The cost of form work is, of course, greater than in the plainer walls, but the appearance justifies the expenditure.

A marked improvement is noticeable in the depots erected on track elevation. Formerly the structures put up were generally of wood and were simply made as a housing for passengers, baggage, etc., without regard to appearance. There are a number of stations recently erected and now under construction, which, while small, are attractive and a credit to the railways. These buildings are frequently of brick, but there are also a number built of concrete.

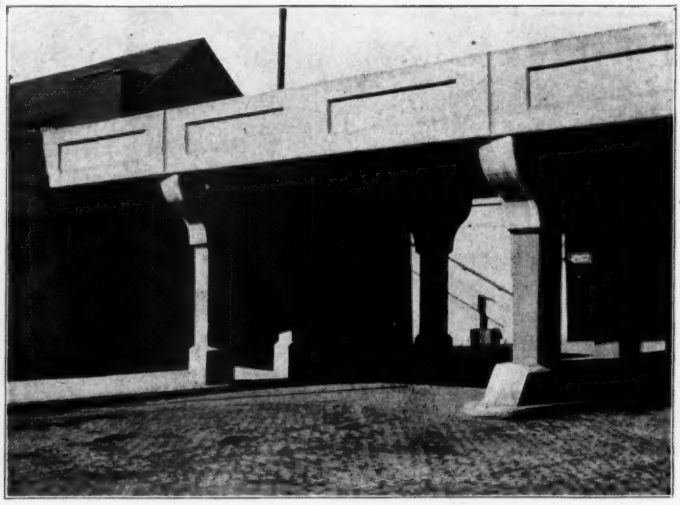
In bridge work steel trough construction, supported by columns, is rapidly superseding the old through-girder spans.



Poor Form Work. Expansion Joints Not Frequent Enough, and Cracks Resulted.



Placing Concrete in Footings by Use of a Chute.



Reinforced Concrete Viaduct.

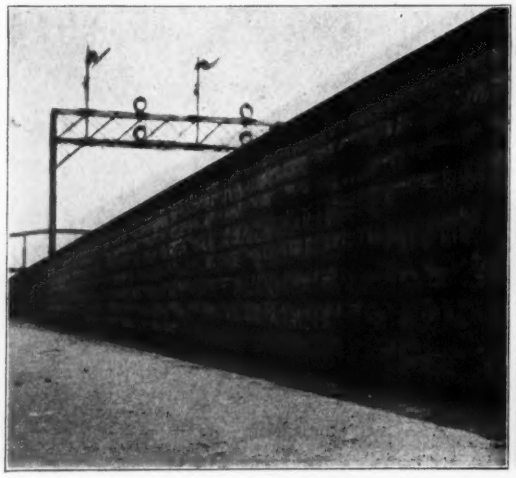
The structures are given a floor coat of concrete and waterproofed. The track is laid on ballast. This type of construction is a great advance over the through-girder bridge; no part of the structure is above ground, and thus there is no liability of accidents due to employes being caught on the bridge, or striking a girder when clinging to the side of a moving train. Ballast floor bridges permit of easier and more perfect maintenance; their advantage is attested by the fact that they are being extensively adopted for all kinds of bridges. The deadening of the train noises is a further reason for their use in bridges over streets. On account of the reduction of vibration and because of the increased depth of the trough floor, waterproofing can be effectively done and should require little maintenance or renewal.

The use of concrete for bridge structures is constantly gaining in favor. Two general types are used. The members of ordinary steel structures are encased in concrete. This construction eliminates painting and other maintenance charges, and by protecting the steel, gives the structure a much longer life. The appearance of these bridges is greatly superior to ordinary steel bridges.

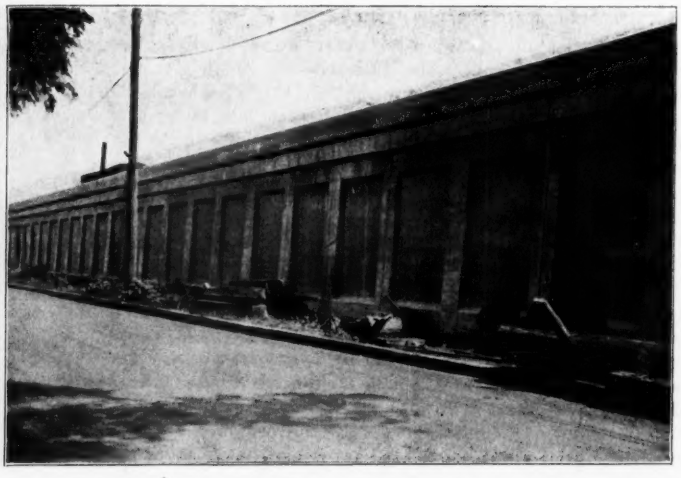
A second type of concrete bridges are those reinforced with steel. These are made of reinforced steel columns, and reinforced concrete slab floors. In general they are more economical than those designed of steel and encased with concrete. In addition to having the same advantages as the latter type, the compressive strength of the concrete is made use of. Reinforced concrete structures will undoubtedly gain in favor and use.

The city government has from time to time increased the head room required beneath street bridges. This has constantly increased the height the track had to be raised above the original elevation. The amount of raise necessary has also been increased by the thicker floors of the later type of bridges. Formerly the policy was to raise the tracks a portion of the head room required and to depress the streets a sufficient amount to make up the rest of this distance. Less filling was required, and the lower height of walls made them cheaper. The following reasons are partially responsible for a large increase in height elevated:

(1) Higher cost of excavation as compared with filling.
(2) Cheaper methods of handling filling.
(3) Trouble with water in depressed streets.
(4) Cost of installation of drains.
(5) Cost and maintenance of paving.
(6) Underground sewers, pipe lines, electric wires, etc., which have to be moved. The result is that now tracks are



Masonry Retaining Wall.

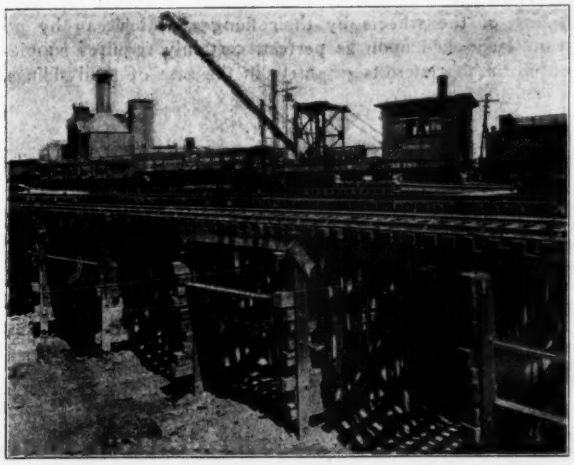


Improved Architectural Appearance Given By the Use of Panels.

put high enough so that in general the streets will not have to be depressed.

On account of the increasing value and expense of buying additional land for right of way, together with demands for more track room, retaining walls are now used in most cases. In the past a simple embankment was built with a natural earth slope, which used valuable space. If at any time later a wall must be put in, the operation is much more expensive. There is the additional earth to be excavated, and a temporary bulkhead, or braced sheeting must be used to support the earth until the wall is completed.

It would seem that most of the improvements herein given show a tendency to greatly increase the unit cost of the work. This tendency towards increased cost has been offset by: (1) Better organization, both of the whole force and of the individual gangs; (2) substitution of concrete for masonry; (3) reduction of excavation yardage; (4) more efficient methods; (5) increased use and efficiency of improved machinery.



Temporary Bridge Bents of Unique Construction.

CONCRETE POLE LINE.

To avoid interruptions by severe storms, or fires from meadow grass, as well as for durability and appearance, the Pennsylvania Railroad has constructed a reinforced concrete pole line designed to carry 60 aerial wires and two 1½ inch diameter lead encased cables for its telegraph and telephone circuits on the north side of its tracks, across the five miles stretch of swampy meadow land between Manhattan Transfer and the portal of the tunnels leading in to the new passenger station in New York City.

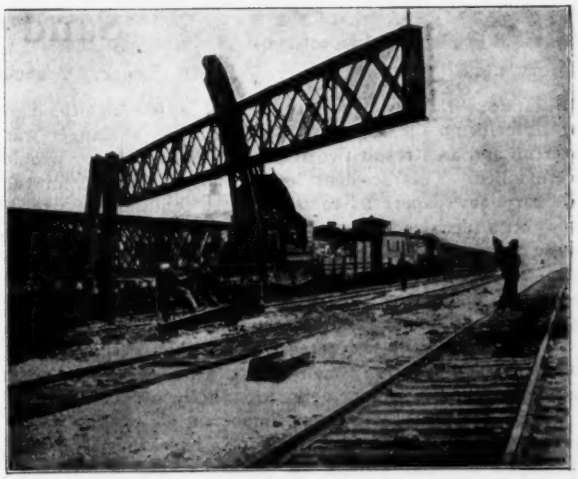
Although the concrete poles were something of an experiment, and were more costly than wooden ones, it was evident that the latter would have been inadequate, while the former were sure to provide a safe and durable construction. A special yard was established near the line for making and seasoning the poles which were turned out at the rate of about six a day.

Two hundred and two poles were required in this section. On account of numerous railway and highway crossings the spans vary from 70 to 135 feet, with an average of 120 feet. The poles are from 35 to 65 feet in length and rise from 25 to 50 feet above the ground. On account of the softness of the earth, the concrete poles had to be supported by specially constructed artificial foundations.

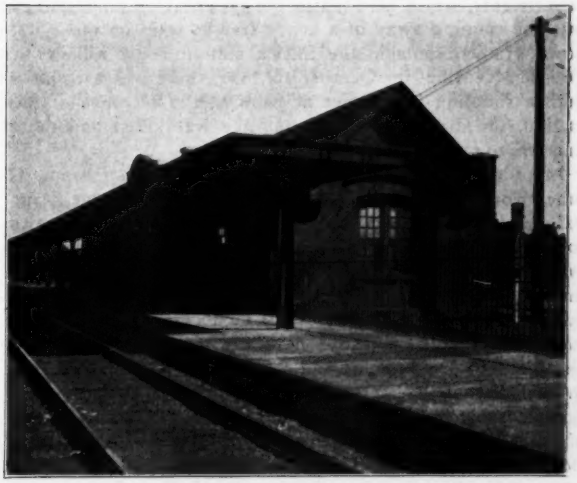
On the south side of the tracks 50-foot steel poles are used to carry the wires for the transmission of traction energy from the tunnel portal to Harrison Sub-station. They are placed 300 feet apart and are designed not only for present needs, but to carry seven additional transmission circuits which may be required in the future. These steel poles are supported by concrete foundations built on the top of groups of from 60 to 90 foot piles driven down through the earth.

Overhead wires instead of submarine cables are used in crossing the Hackensack River in order to preserve the integrity of the line against lightning disturbances and to provide for the use of 33,000 volt transmission.

To do this it was necessary to maintain the clearance prescribed by the War Department, which involved the construction of two high steel towers. The line approaches the river on 50-foot poles, rising to an intermediate 70-foot pole, and then directly to the tower, 181 feet 4 inches above high water. The wire span over the river has a length of 765 feet.



Handling a Heavy Bridge Member with a Derrick.



Concrete Suburban Line Station.

The Grand Trunk is in the market for 10,000 tons of rails for New England delivery.

The George A. Fuller Company, Chicago, has ordered 14,000 tons of structural material for the new Kansas City Union Terminal work, from the American Bridge Company.

The Boston & Albany is said to be in the market for 5,000 tons of bridge material.

Sand Sidings

By Dr. Köpcke, Councillor, Engineer, of Dresden.

A serious railway accident occurred a few months ago at Mulheim on the Rhine; a signal standing at danger was overrun and as a result two trains collided and many people were killed. This accident led to many criticisms in the ordinary newspapers as to the mental condition of people who at a decisive moment act wrongly. In several cases these newspaper articles explained the want of rational action on the part of the people concerned by complicated psychical phenomena; this amounts in short to the statement that to err is human, and that consequently such accidents can never be wholly prevented. Now although this can not be disputed, the railway man must ask himself whether the existing technical arrangements are wholly satisfactory.

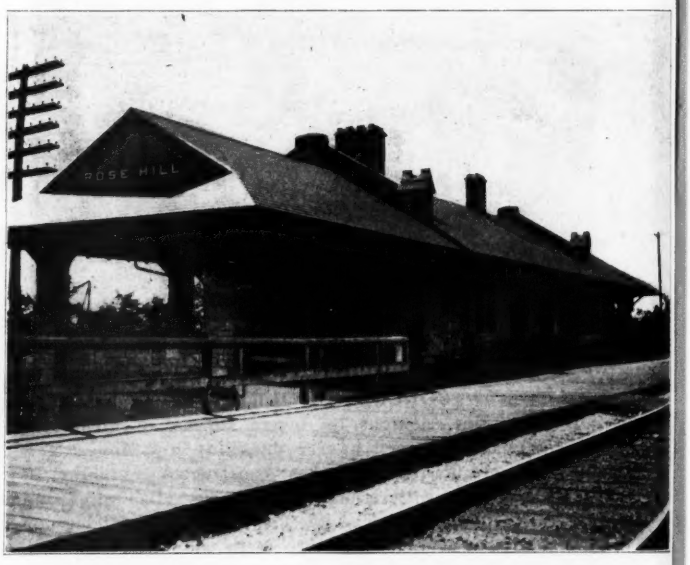
In this respect there is an important defect in the arrangements hitherto made; the signals have, it is true, been developed to such a pitch of perfection that if they are properly observed by the train staff, collisions become practically impossible under ordinary conditions; but at present, in Germany at least, there are no devices which independently of the train staff, prevent a train from going ahead when the signal is at danger, and so could obviate the consequences of neglecting to put on the brakes at the proper time, etc. Among the devices proposed as a remedy there is the sand siding, which has now been known for eighteen years. A few applications of it have been made in Germany and Austria, especially on the Saxon State Railway. Now as such sand sidings have as yet not been included among generally-recognized safety appliances, and as they have hardly so far been used and nothing is generally known about how they act, I look upon it as a duty on the occasion of such a striking accident as that at Mulheim, to draw the attention of colleagues once more to the sand siding and also to discuss some of its peculiar features.

Application and Conditions of Construction of First Sand Siding.

The immediate cause which led to the investigations and experiments, which resulted in the proposal of sand sidings, was the running away of a heavy freight train on the 1 : 55 down gradient outside the Silesia station (now rebuilt) in Dresden-Neustadt on October 12, 1890; there was a collision with a shunting locomotive at work at the entrance of this station, the driver of this locomotive was killed and much damage to rolling stock resulted.

In order to prevent the recurrence of such an event, in other words, in order to stop a train which over-runs a signal standing at danger (whether this is due to negligence or to a failure of the brakes), one may adopt devices very generally used in England at places where sidings connect with main lines, in order to protect the latter, and known as derails; these divert a runaway train on to ballast which brings it to a standstill. But this naturally involves considerable risk both to the vehicles and to their contents, which may in fact become entirely destroyed, and consequently it is not advisable to adopt this means in the case of transports of value. It therefore became desirable to find a means of stopping the runaway train without damage, and this can be effected by diverting it not on to the ballast, but on to a siding which like it opposes greater resistance to movement. Steeply-ascending safety sidings (sometimes called catch sidings), such as have been constructed at various places by English engineers, cannot be used generally, and at the place in question they were wholly excluded as no room was available for such a siding; it therefore was considered whether it would be possible to construct a siding with the switches giving access to and from it as near as possible to the running lines, such siding to be covered with sand so as to offer a considerable but uniform resistance to all the wheels of the runaway train, a resistance which on earth and sand amounts to from 0.08 to 0.3 of the wheel-load. Preliminary experiments on a gravel-pit siding, the results of which have been widely published, confirmed these expectations. A layer of sand about 2 to 3⅛ inches deep was used, and the first time of using it gave a resistance of from 1-12 to ⅛ of the wheel-load.

At first sight it would seem that the layer of sand would tend to lift the rolling surface of the wheel and eliminate the guiding action of the flanges, and therefore in the case of longer sidings guards were introduced from the beginning. Nevertheless, both in the case of longer and of shorter sand sidings, if straight, it was found that the sand after it had once become settled was then quite efficient to stop a train, if the sand became strongly pressed together to a thickness of only about ⅝ inch, so that the guiding action of the wheel flanges was not wholly lost. The rather deficient guiding of the wheels by their flanges, which can by no means be looked upon as perfect, certainly requires supplementing in the interests of safety in the case of sand sidings,



Attractive Suburban Station, Masonry Construction.

not only on curves but also on tangent; this is effected by check rails, and provision must also be made against the displacement and removal of the sand. Rails and other rolled sections, as well as timber baulks, were used for this purpose. The first practical application of a sand siding was made at the place mentioned above; a siding 547 yards long was fixed (without frog) on the sleepers of the running line by which freight trains entered Dresden-Neustadt station; longitudinal baulks were fixed to these sleepers so as to form a trough to hold the sand (which was in a layer 2 inches deep) and also to help guide the wheels. Matters were arranged so that every freight train which over-ran the signal was diverted to this sand siding. Such cases occurred once in December 1895 and once in 1897; the results were satisfactory. The track was quickly cleaned afterwards and the freight train could resume its journey after only about 24 minutes of delay. This sand siding existed during six years, and during this period it only came into use on the two above-mentioned occasions, although during this

time about 26,000 trains passed the place in question. This tends to show that frequent erroneous diversion of trains to the sand sidings, which would delay the traffic, can certainly be avoided.

Sand Sidings at Dresden.

After Dresden-Neustadt station had been rebuilt, the main lines were no longer used for shunting purposes; consequently that sand siding was no longer necessary. On the other hand, the rearrangement of the station gave occasion for the construction of several sand sidings at other points.

Two sand sidings in the form of passing loops, 71 and 115 yards long, respectively, were constructed at the Dresden-Friedrichstadt sorting and shunting yard and are now in regular use. Occasionally runaway cars are caught on them.

The need of sand sidings is due to the local conditions of the Dresden-Friedrichstadt sorting and shunting yard, as the whole of it is on a gradient of 1 : 100. Consequently no humps or saddle backs are necessary as the cars wherever they may have been stopped can always be started again by gravity. While sorting according to direction and station, and while making up a train, the cars are stopped by means of skids, etc., on the sorting siding and grids. If, however, a car or a string of cars accidentally runs beyond the point at which it should have been stopped, provision must be made for stopping without damage, and the sand sidings are provided for the purpose. The greatest length a car can run is about 1,094 yards and the maximum speed it can attain is about 28 miles per hour. Two to three shifts of men work at the yard and every day from 7,000 to 10,000 axles are received and dispatched.

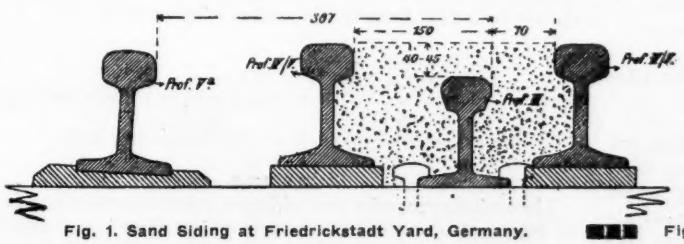


Fig. 1. Sand Siding at Friedrickstadt Yard, Germany.

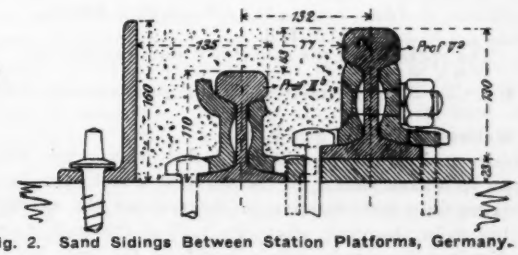


Fig. 2. Sand Sidings Between Station Platforms, Germany.

Fig. 1 shows the cross-section of one-half of the sand siding at Friedrichstadt yard; the timber baulks previously used for retaining the sand and for guiding the wheels are here replaced by old rails. The distance between the sand rail and the running rail, center to center, is 1 ft. 2 7/16 in. At the chief Dresden-A. station a sand siding with entrance switch was provided for stopping passenger trains, after trains had several times run into the buffer stops; the sand siding is a dead-ended one. Although no accident has as yet been prevented by this sand siding, its presence at this busy spot has once more proved that irregular or too fast arrivals of trains can be avoided.

Fig. 2 shows the cross-section of one-half of this sand siding, which is between two passenger platforms. In order to provide a sand siding between the two platforms, the edges of which are only 10 ft. 2 in. apart, the running rails had to be used as the one wall of the sand trough, the horizontal distance between the sand rail and the running rail, center to center being reduced to 5 5/16 inches. The running line had been built without reference to the sand siding; the two platform edges were only 10 ft. 2 in. apart, and in order to obtain the necessary clearance it was necessary to raise the running lines by 1 9/16 inches so that the rolling surface is 1 ft. 1⅜ in. below the platform level instead of 1 ft. 3 in. In order to bring this sand siding into use the switch giving access to it is set a short time before a train arrives and it is only thrown over by the signalman at the entrance to the siding (who also has other duties to attend to) when the locomotive driver of the arriving train has informed him, by means of a whistle signal, that he is able to stop the train by means of the brakes.

At Kratzau station, there is also a loop 137 yards long, for protection against runaway trains from the direction of Reichenberg and provision is made for adding two sand sidings for protecting the Dresden-Elsterwerda and Cossebaude-Naundorf-Weinbohla sections when these lines are doubled.

General Calculations. Examples.*

The determination of the value f of the rolling resistance on a given sand siding is effected by measuring the distance s which a car or axle moving at a speed of v per second runs before it stops.

Let M = the mass of the car, and Mg = its weight, where g is the acceleration due to gravity; then the kinetic energy is $\frac{Mv^2}{2}$. If this energy has become absorbed while running the distance s on the sand track, it is equal to the work of friction; thus

$$\frac{Mv^2}{2} = Mgfs \text{ or } s = \frac{v^2}{2gf},$$

whence

$$f = \frac{v^2}{2gs}$$

The retardation G per second is $G = fg$. The time t of running on the sand track is given, just as in the case of a body falling freely and thrown vertically upwards, by the equation

$$s = \frac{Gt^2}{2} = \frac{fgt^2}{2}$$

and as

$$v = fgt$$

it follows that

$$s = \frac{vt}{2} \text{ and } v = \frac{2s}{t}.$$

The initial speed v is therefore double as great as the mean speed while running on the sand track, and by substituting this value in the equation for f we obtain the coefficient of resistance

$$f = \frac{2s}{gt^2}.$$

It is hence not necessary to measure the speed independently, but only the time and the distance the wagon runs on the sand track.

The energy of revolution of the wheels has to be added

*All the calculations given in this paper are approximations. That is all that is necessary.

to the energy of the forward movement of the whole mass M; this is done most conveniently by adding a corresponding fraction. For each pair of wheels, we have to assume at the wheel circumference and accordingly at the same speed, about 400 kilograms (882 lb.) as the average; in the case of an empty four-wheeled freight car having a tare weight of 5 tons this gives

$$\frac{2 \times 400 \times 100}{5{,}000} = 16 \text{ per cent of the tare,}$$

and in the case of a loaded car, gross weight 15,000 kilograms (33,070 lb.), 5.3 per cent of that weight.

If the sand siding is on an up or a down gradient, the corresponding fraction has to be subtracted or added to the value of f.

First example.—A fully-loaded four-wheeled car which ran away at Friedrichstadt station was caught on a sand siding having a down gradient of 1:100. The two axles of the car ran 91 metres (99.5 yards) on the sand track before it stopped, and the time taken was 15 seconds. What was the value of f? The above equation gives:

$$f = \frac{2 \times 91}{9.81 \times 15^2} \times 1.053 + 0.01 = 0.09683.$$

The speed when the sand track was reached was

$$v = \frac{2 \times 91}{15} = 12.1 \text{ metres (39.70 ft.) per second or 43.6 kilometres (27.1 miles) per hour.}$$

It need hardly be mentioned that when whole trains run on to a sand siding, all the different wheel pairs have to be taken into consideration in determining the energy which has to be absorbed; where the load of the train is uniformly distributed over the whole length of the train we can take as basis the path described by the center of gravity of the train.

Second example.—At the chief station of Dresden there is a sand siding 64 metres (70 yards) long for trains coming from Görlitz; this is a dead-ended siding. Let us assume that the length and the weight of the locomotive plus tender are 16 metres (52 ft. 6 in.) and 2.5 tons (2.46 English tons) respectively, while the passenger train has a uniform weight of 2.5 tons per metre (0.75 English ton per foot) of length. What is the braking effort of the sand track if $f = 0.1$?

The length of the train is $64 - 16 = 48$ metres (157 ft. 6 in.), and its weight is $48 \times 2.5 = 120$ tons; the path described by its center of gravity has a length of $\frac{64 - 16}{2} = 24$ metres (78 ft. 9 in.), and that of the locomotive and tender $= 64 - \frac{16}{2} = 56$ metres (183 ft. 8¾ in.); consequently, the braking effort is

$$A = 0.1\ (75 \times 56 + 120 \times 24)$$

$= 708$ ton-metres (5,121,063 foot-pounds); and allowing 6 per cent for the energy of the rotating masses, we have to take $(120 + 75) \times 1.06 = 206.7$ tons (203.4 English tons) as the mass of the whole train; the corresponding velocity of the train, which has to be stopped, is

$$v = \sqrt{\frac{2 \times 9.81 \times 708}{206.7}} = 8.195 \text{ metres (26.887 ft.) per second or 29.5 kilometres (18.3 miles) per hour.}$$

I will now mention some of the results obtained which have become known to me.

Results of Observations.

The freight train which arrived at Dresden Neustadt from Görlitz on December 21, 1895, could not be stopped, as it should have been, at signal A, where there is a down gradient of 1:55; according to the estimate of the signalman, it ran past the signal at a speed of about 40 kilometres (25 miles) per hour (= 11 1/9 metres [36.45 ft.] per second). It was diverted onto the sand siding, where it was stopped after running the further distance from A to E = 600 metres (656 yards), 300 metres (328 yards) of which were sand siding; the corresponding fall

$$\text{was } \frac{500}{55} + \frac{100}{58} = 10.7 \text{ metres (35 ft. 1 5/16 in.)}$$

The weight of the train, locomotive and tender included, was 417 tons (410.4 English tons); adding the inertia of the rotating masses we have to allow for 417 $(1 + 0.055) = 440$ tons (433 English tons).

The total amount of energy the sand track and the brakes had to absorb, not taking the rolling resistance on the unsanded part of the track into consideration, thus was

$$A = \frac{417 \times 1.055 \times (11\ 1/9)^2}{2 \times 9.81} + 417 \times 10.7 = 7{,}230.5 \text{ ton-metres}$$

(52,299,219 foot-pounds), corresponding to a final velocity of the 440 tons (433 English tons) of moving mass of

$$v = \sqrt{\frac{2 \times 9.81 \times 7{,}230.5}{440}} = 17.956 \text{ metres (58.912 feet) per second, or 64.6 kilometres (40.1 miles) per hour.}$$

Maintenance.

The maintenance of a sand siding requires a certain amount of care and supervision. But the object aimed at, namely the prevention of serious accidents, certainly makes such care worth while.

It is readily intelligible that doubts can exist as to the advantage of such a safety appliance which only seldom comes into action and is as yet not of general application, and that the smallest failure can naturally lead the designer himself to express an unfavorable opinion about it. Hence every instance in which a sand siding has come into action is of importance, and I therefore draw attention to the interesting information published by von Borries in the Zentralblatt der Bauverwallung, 1908, No. 37, who mentions interalia that a train which ran on to a deadened siding having a layer of sand 1 3/16 inches deep, with a speed of 16.40 feet per second, was stopped without the use of brakes when the leading locomotive axle had traveled a distance of 68 yards. The train weighed 158 tons and the energy which had to be absorbed is calculated at 446,628 foot-pounds.

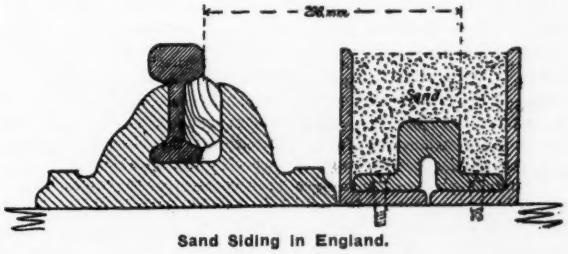
Position and Use of Sand Sidings.

In order that a sand siding may fulfill its object, several methods may be adopted. For instance, a switchman is placed at the switch giving access to it, and he sets the switch so as to give this access either at his own discretion, or at the request of the driver, or when the signal stands at danger. The switch may be interlocked with the signal, so that if the latter stands at "danger" the train is automatically diverted to the sand siding. In those cases in which both signal and switch have to be operated by one and the same signalman who is in the immediate proximity, as is the case with several sand sidings on the Saxon State Railway, there is evidently no difficulty in this combination. Matters are different in the case of arrival tracks at stations. In the first place, there is an intelligible objection against any further extension of the already-complicated and expensive safety appliances; then also the operation of switches from a distance, by means of a wire transmission, is difficult and uncertain. These are probably the reasons why sand sidings

have not become more generally used, and more especially why they have not been pushed by manufacturers of signals and switches. Opinions may change, however, when electric or electric-pneumatic operation of switches and signals has become general, and in any case it may be doubted whether any further attention will be paid to the danger now feared, that a further reduction in the risks of train operation will tend to reduce the watchfulness of the train employes, so as to counterbalance or more than counterbalance the gain in safety aimed at. Thus the removal of the risks, which our predecessors always incurred when there were no electric telegraphs, has not been any obstacle to increase of safety.

Braking by Means of the Sand.

Various proposals have been made for stopping trains, and some of these have been tried, especially in North America, such as operating the brakes by means of a lever projecting from the track and acting either directly or indirectly on the brake mechanism, and such arrangements may certainly reduce existing risks. But apart from the difficulty of designing mechanical contacts which are reliable, it must not be left out of consideration that accidents are not infrequently caused by a failure of the brakes, and that the braking effect is materially reduced at very high speeds, when the wheels skid on the rails. There is no doubt that in such a case a sand track is useful, because it prevents the skid-



Sand Siding in England.

ding of the wheels; this is confirmed by the observation that locked wheels which are skidding again begin to revolve, so that the brakes again act properly, when sand is put on the rails. Consequently a sand siding may be of use conjointly with the automatic application of the brakes, and the strong braking effect on a train which is skidding, which results if a layer of sand is present, increases the safety very materially; for the resistance of 1/10 is increased to 1/3 of the braked wheel-load, or even to more.

Sand Sidings and Buffer Stops.

Sand tracks with check rail, or without check rails in cases where derailment causes no serious risks, have been constructed at various points, for instance at the bottom of steep gradients or at stations which are on gradients, for stopping trains or individual vehicles, and have several times already exercised their functions. Some of these sand tracks are of considerable length. At sorting and shunting yards there are many dead-ended sidings covered with sand, generally rather short. Now, although at passenger stations the lengths of sand track in front of the buffer stops are generally too short so that the latter are hardly relieved, yet such lengths of dead-ended track as 22 to 66 yards are very efficacious, and as compared with buffer stops and sand heaps, must reduce damage to rolling stock. Besides buffer stops capable of absorbing considerable amounts of energy, other devices have also been tried, namely movable buffer stops, somewhat like skids. Such movable stops have also been used in Saxony (Chemnitz), but designed on a somewhat different principle; their value is probably beyond dispute and they have given good results at moderate speeds. Nevertheless sand sidings are to be preferred for the purposes, and ensure gradual stopping, without shock, better and at higher speeds than buffer stops and skids. A special advantage is that no otherwise useful room has to be occupied, as the line can extend right up to the end or cross platform, while the space required for a Rawie stop, in order to stop a train having a speed of 11.97 miles per hour only, is stated to be 19.63 yards.

As the collision between two trains, which occurred on the open line at Mülheim on the Rhine, was the immediate cause which led me to write this paper, I want to emphasize that I chiefly wish to draw atttention to the use of sand tracks in order to stop trains when the signal is standing at "danger," at points at which stopping is not compulsory (as it is at terminus stations) but I also do not wish to remark that the energy represented by heavy trains moving at high speeds can be absorbed by sand tracks, but not by buffer stops.

Kind of Sand.

The properties which the sand or similar material used to cover rails must have are the following: it must give as much resistance as possible; this resistance results from the friction of the surface and the crushing of the particles. It must be permeable, so that when properly drained it remains loose and it cannot become frozen together in the coldest weather. Whether a given sand which is available possesses these properties and hence is suitable for a sand track, can only be determined with certainty by means of experiments. Somewhat coarse sand from a river or pit has proved satisfactory. Among other materials used on sand tracks here, crushed syenite has given good results for several years, both as regards resistance and as regards remaining loose in cold weather. This crushed syenite consists of the waste of a syenite quarry, at Plauen, where sets and road metal, for use in towns, are obtained. This waste is treated, cleaned, and screened repeatedly; the grains obtained vary in size between 1 3/16 and 2 inches, and the sand troughs are filled with this material so that the layer above the rails has a uniform depth of from 1 9/16 to 2 inches. Even in cold winters and when thaws and frost have repeatedly succeeded each other, this syenite has not become frozen together so as to form a hard mass. Fine dry sand, used without troughs, has on the other hand proved quite ineffective and consequently useless, as the wheels merely pushed nearly all of it off the rails.

As the stopping power of the sand sidings at Friedrichstadt Dresden sorting and shunting yard can be tested at any time by allowing sets of cars to run down the hill, and such experiments are readily shown, by permission of the general directorate of the Saxon State Railway to visitors, other managements desirous of information on the subject need make no trial installations, but only have to come to Dresden to see trials, as many engineers have already done.

WOOD PRESERVATION.

The preservation of wood is an old art and has been practised since the beginning of the eighteenth century. In 1705, Homeberg soaked wood in a weak aqua solution of corrosive sublimate. In 1730, Job Baster treated wood with an aqua of corrosive sublimate and arsenic for shipbuilding purposes. In 1740, Reed used wood vinegar. Fagot used alum, iron vitriol and steam. This treatment of Fagot's in 1740 is the first noticed using steam for the preservation of wood. In 1756, Hale treated wood with a solution of tar oil and wood vinegar. About this time the process generally used for preserving wood was to dip it in boiling hot wood tar. In 1756, Jackson used a mixed solution of sea salt, lime, sulphate of zinc, alum, epsom salt ashes and sea water. From 1767 to 1812, the solutions just mentioned were used in a variety of ways. In 1812, coal tar was first used by Cook for the pres-

ervation of ships and ship timber. In 1823, Oxford used for the first time oils distilled from tar, applying them to the wood as paint. In 1835, Moll was the first to use the vapors of wood tar and creosote, the wood being enclosed in tight chambers. In 1838, dead oil of coal tar was first introduced as a preservative of timber by Mr. Bethell in England. In 1848, May also treated wood according to the present method, with heavy tar oils or creosote. The wood was first subjected to superheated steam, and then to creosote vapors in a cylinder under pressure.

In the creosoting process, the prevention of decay is accomplished by filling the pores of timber with creosote oil, a strongly antiseptic substance, the presence of which will prevent all vegetable or animal growth including the bacterial growth commonly known by the name "decay." The reason of the superiority of creosote oil over such other treatments as "Zinc-Chloride" lies in the greater stability of creosote oil, which does not easily leach out in the presence of moisture, and it is little affected by evaporation.

The essentials of first class creosote treatment are that all surplus sap and resin shall be removed, and that the oil shall penetrate the timber thoroughly and to as great a depth as possible. The removal of the sap is necessary in order to empty the cells and allow the introduction of creosote oil and also for the reason that lumber is subject to decay so long as the sap remains in the timber.

This phenomenon is customarily known as "dry rot," and occurs as follows: Unseasoned timber, piled under cover and in such a position that the air will circulate around it, will become seasoned, first on the outside and eventually to the center of the timber. If, however, before the sap is evaporated from the center of the timber it is placed underground or if the evaporation of the balance of the sap is prevented in some other manner, decay will commence, starting in the center of the timber and working outward.

Engineers are well aware that unseasoned timber laid in concrete becomes quickly destroyed by "dry rot." The same thing has also happened to office floors laid on concrete and covered over with linoleum, owing to the fact that the linoleum prevents evaporation of the sap in the lumber. The same action may be occasioned by imperfect creosoting or by painting a partly seasoned stick of timber with pitch or some waterproofing oil, which although valuable as a waterproofer and not harmful to perfectly seasoned lumber, is certain to hasten the decay of lumber from which the sap has not been removed.

The Wyckoff Pipe and Creosoting Company, which furnished the material for this article, has a plant with a capacity of 100,000 feet B. M. per day. The plant consists of: a saw mill with machinery for boring spike holes in ties, and for manufacturing conduit and paving blocks; a blacksmith shop; a machine shop; an electric light plant; and a laboratory in which tests of creosote oil and of creosoted lumber are made.

Process of Treatment.

The removal of the sap is accomplished by a double process. First, subjecting the timber to live steam under a pressure of between thirty to forty-five pounds to the square inch from three to seven hours, according to the size and condition of the timber. Second, immediately thereafter subjecting the timber to a vacuum of twenty to twenty-four inches of mercury maintained until all the sap and moisture possible has been extracted from the timber.

When dry heat is used the sap is baked into the wood, clogging up the pores, while steam softens up all sap and when the vacuum is applied it is all taken out of the wood: the pores are thus left empty and open, allowing more oil to penetrate the wood than if the pores were clogged with hardened sap. Another advantage of steam over dry heat is that dry heat injures the strength of the wood while steaming does not. In fact, creosoted wood often is stronger than the wood before being creosoted.

While the wood is still warm from the effects of the steaming treatment and while a seventy-five to ninety per cent vacuum exists in the pores of the timber, the oil is admitted into the treating cylinder and is sucked into the pores of the wood by the existing vacuum to the extent of a number of pounds per cubic foot. Hydraulic pressure is then applied and continued until the wood has been impregnated with the required amount. The quantity usually required is twelve pounds of oil per cubic foot, which experience has shown is sufficient to prevent decay in ordinary situations. For some classes of timber, such as oaks and long leaf yellow pine containing quite a percentage of heartwood, a less quantity may be safely employed. In certain classes of timber it is customary to use even more than twelve pounds per cubic foot.

The two chief examples where heavier treatment is advisable are creosoted piles to be used in tropical waters and exposed to severe attacks of the teredo, and creosoted wood paving blocks, where not only are the conditions very trying and productive of decay but where it is also desirable that the pores of the wood be filled as completely as possible to prevent absorption of water sufficient to cause buckling of the finished pavements.

To fill the mechanical requirements of these processes, expensive closed treating chambers are required. The vacuum process requires that the chamber withstand outside air pressure to the amount of fifteen pounds per square inch, as well as the hydraulic pressure used in forcing oil into the wood. The chambers are accordingly constructed of boiler plate in the farm of cylinders, usually about six feet inside diameter and one hundred feet long. The cylinders are equipped with narrow gauge tracks, and the lumber to be creosoted is loaded on metal trucks which are hauled into the cylinder by means of a donkey-engine or a narrow gauge locomotive.

Results of First-Class Creosote Treatment.

It is a well established fact that the creosoting process, properly administered, will absolutely and entirely prevent decay of all portions of the timber penetrated by the creosote oil. The Department of Agriculture, dealing with various methods and processes of preserving wood, reports as follows:

"The method used in England, Belgium and France—the creosoting treatment—is the most costly and at the same time the most effective in preserving wood."

"The Scotch pine is a kind of timber which corresponds closely to some of our Southern pines. It is a soft wood, which would last but a few years in an untreated condition. When treated according to the best English methods, ties made of this timber have lasted twenty-five years or more."

"The use of creosote for preserving timber has been shown by the experience of the English and French lines to be beyond question a method which protects those parts injected with it absolutely. Such timbers as can be wholly impregnated with creosote will never rot. They may wear out because of mechanical abrasion."

"Impregnation is worth nothing at all if not well done."

The exhaustive studies of the Department of Agriculture may be summarized as showing:

1. The absolute immunity from decay of thoroughly creosoted lumber.

2. The great superiority of the Creosote Treatment as compared with Zinc-Chloride and other preservative treatments.

3. The importance that creosoting, if done at all, should be done thoroughly.

A treatment of not less than twelve pounds of oil to the cubic foot of timber should be used. The quantity of oil used on each treatment of lumber is exactly determined by gauges, measuring tanks, etc., and the process and quantity of oil should be open to the verification of inspectors. Not less

important than quantity of oil is uniformity and thoroughness of distribution of oil in the timber, and this is largely a matter of expert knowledge on the part of the creosoter as to the proper duration of the steaming and vacuum processes.

Creosoted trunking and capping for signal wires can be made to any desired size or specification. A common size is the 3 x 4 inch trunking, consisting of 3 x 4 inch yellow pine in lengths of 12 to 16 feet grooved 1½ x 1½ inches, and covered after the wires have been placed with 1 x 4 inch capping. The construction allows immediate access to any portion of the wires by merely removing the capping, and obviates the necessity of pulling through the wires.

The first cost of creosoted cross-arms is somewhat more than that of uncreosoted arms. Large users, however, find great economy in their use owing to the less frequent renewals required, obviating not only the expense of new cross-arms, but also the considerable expense of erection. The prices of the best grades of wood, such as cedar, oak, cypress and 75 per cent heart long leaf yellow pine, are becoming so high that uncreosoted cross-arms of such timber cost nearly or quite as much as creosoted cross-arms of cheaper timber. For creosoting purposes, sound and square edge grade of short leaf or long leaf yellow pine (with no restriction as to proportion of heart) is recommended, and when creosoted, is more durable and better than uncreosoted cross-arms of the more expensive grades of timber.

Penetration of Creosote in Pole, 4 feet Above Ground.

All yellow pine cross-arms whether creosoted or not, should be free from knots at such points as would impair their strength, as in the center of the arm or near the brace holes. Sound knots near the ends of creosoted cross-arms are not a practical defect as they do not decrease the strength, while the creosoting process prevents decay around the knot.

Untreated telegraph poles decay very rapidly at the ground level, or just below it, as all the requirements for rapid decay are there present, these being air, moisture and a certain amount of warmth. Creosoted wooden poles are much superior to iron poles because they cannot rust; they are non-conductors of electricity; they do not have to be painted; they last much longer, and they cost less.

At the present prices of lumber and labor, the item of replacing cross-ties is one of the heaviest items in railroad maintenance. Economists agree that lumber must inevitably increase rather than decrease in price and it is, therefore, probable that tie renewals in the future will be even more expensive than at present.

The average life of an oak tie is from four to eight years. Creosoted ties, provided with tie plates and screw spikes, have lasted for thirty years in France on the French & Eastern Railroad, between Paris and Strassburg. It will be seen that the life of the creosoted tie, properly treated, is more than three times that of a first-class untreated tie. The majority of the large railroads of America and Europe find it profitable even at present prices of lumber to use creosoted ties.

It is always advisable to use tie plates with creosoted ties in order to obtain the full advantage of their freedom from decay. It is also desirable to use screw spikes for the same reason. A screw spike requires that a hole be bored in the tie, into which the spike is screwed. The result is a great holding power for the spike and no abrasion of the tie and "wearing loose" of the spike in the course of traffic. This style of construction requires four holes bored in each tie, that they be bored exactly opposite the punchings in the metal tie plates and that the two pairs of holes in the respective ends of the tie be spaced to exact gauge.

It is very desirable that screw spike holes be bored before creosoting. Thus the oil penetrates to the full depth of the spike and throughout all the immediate vicinity of the spike. Decay of the tie frequently commences at the spike hole of uncreosoted ties and decay at this point is more dangerous than at any other part of the tie. Uncreosoted ties often check open when the spike is driven. The ensuing crack becomes filled with water, does not dry out and decay starts. Screw spikes with holes bored overcome this difficulty. All the arguments in favor of creosoted ties in ballast apply to bridge ties with the additional one that labor cost of renewals of bridge ties is more expensive than for ordinary track ties.

Excavation work for the new million dollar hotel of the Canadian Pacific at Calgary has been begun. This hotel will be one of the finest of the Canadian Pacific Railway's whole system of seventeen hotels.

The International & Great Northern is providing additional car repair facilities at Taylor, Tex.

The Esquimault & Nanaimo has given a contract for a new station at Cameron, Lake, B. C., to W. C. Holt, Victoria.

The Northern Pacific is about to begin a $10,000 grade separation project at Dale, Minn.

The Pennsylvana R. R. is about to erect a large hotel of the modern resort type at Colon Beach. The cost will be about $500,000. Steel and concrete construction will be employed.

The Mobile & Ohio has plans for a warehouse and wharf at Mobile, Ala., on which the Jett Bros. Construction Co., of Mobile, is the lowest bidder at $125,000.

It is planned to equip the entire Panama R. R. with automatic block signals and to install interlocking plants at all points requiring the protection and facility of operation which they afford.

The Texas Central, the Abilene & Southern, and the Kansas City, Mexico & Orient are considering the erection of a union station at Hamlin, Tex.

The Central Railroad of New Jersey has placed the contract for two small highway bridges, requiring 200 tons of material, with the Pennsylvania Steel Co., and the contract for a Scherzer lift bridge over the Elizabeth river, requiring 300 tons, has been placed with the Phoenix Bridge Works.

Concrete in Railway Construction

Continued from page 372 (August Issue).

CHAPTER X.

Signal Towers, Water Tank Supports and Bumping Posts.

Signal Towers.

Railways throughout the country are experiencing a period of architectural renaissance. Structures which have in the past been built of temporary construction, apparently regardless of outward appearance, are being replaced by permanent buildings of artistic design. This is particularly true in the case of signal towers, the old unsightly and necessarily temporary wooden structures being superseded either by entire concrete or combination concrete and brick towers of pleasing appearance and permanent construction.

Naugatuck Junction Tower, N. Y., N. H. & H. R. R.—With the exception of the roof, which is of Ludowici Celadon tile on wooden rafters, this tower is of concrete construction throughout. The foundation and both exterior and interior walls are of plain 1:3:5 gravel concrete, while the floors are of 1:2:4 gravel concrete reinforced with No. 16 2½-inch expanded metal.

As will be seen from the photograph in Fig. 36, the architectural treatment of the building is enhanced by the use of indented arches over the lower windows, and by a projecting ornamented belt course which runs around the entire building and serves as a lintel for the upper windows. The roof is designed along pagoda lines with a very pleasing result.

The tower was designed by the engineering department of the railroad and built by its building department in 1906.

Kingsbridge Tower, N. Y. C. & H. R. R. R.—The standard signal towers of the electric zone of the New York Central & Hudson River R. R. are combination brick and concrete structures. The footings and foundation walls below grade are of 1:4:7½ concrete, and the walls above grade up to the first floor level are of 1:3:6 concrete. All the sills and lintels, the coping, the overhanging bay window and supporting brackets and the cornice are of 1:2:4 concrete.

The excellent finish of this work was obtained by floating the green concrete with water and rubbing it with a mortar brick composed of 1 part cement to 2 parts sand. The floor and roof construction consists of 1:2:4 concrete slabs, reinforced with ½-inch round rods, supported by steel I-beams.

Grove St. Signal Tower, D., L. & W. R. R.—This tower, located about 250 ft. west of Grove street, Hoboken, is built entirely of reinforced concrete and was designed and constructed by the engineering department of the Delaware, Lackawanna & Western R. R., Mr. Lincoln Bush, chief engineer, and Mr. F. J. Nies, architect.

There are several interesting features of construction in connection with the tower which are somewhat out of the ordinary. The side walls rest on creosoted piles spaced 2 ft. 8 ins. apart, while the front and rear walls are carried by reinforced concrete girders spanning from side wall to side wall. At the first floor level there is a concrete platform leading to the iron stairs in the rear, which is supported on reinforced concrete brackets cantilevering 3 ft. from the side wall of the building. The roof, which overhangs 1 ft. 10 ins., and appears from the ground to be flat, is a reinforced concrete slab pitching from a thickness of 3 ins. at the walls to 10 ins. at the center. With the exception of the overhang, which is flashed with 16-oz. copper, the concrete slab is covered with slag roofing. The concrete for the entire building was mixed in the proportion of 1:2:4, and all exposed surfaces were rubbed.

In designing the tower a ratio of elasticity of 15 was assumed, and the concrete was figured at 600 points per square inch fiber stress, 500 pounds per square inch direct compression, and 50 pounds per square inch shear, while the steel was given a tensile stress of 16,000 pounds per square inch.

Water Tank Supports.

Owing to its strength, rigidity and resistance to fire and decay, reinforced concrete is aptly suited for the construction of water tank supports.

Water Tank Support at Waterbury, N. Y., N. H. & H. R. R.—This tank support, octagonal in form, is 30 ft. 9 ins. wide, with the platform carrying the water tank 40 ft. above the ground line. It is designed to carry a 55,400 gallon wooden tank.

The method of reinforcing the supporting columns presents a rather unique and interesting feature. This reinforcement consists of two 95-lb. third rails placed back to back and riveted every 3 ft., making a section in the form of a star strut.

The platform, which is 9 ins. thick, is reinforced with ½-in. corrugated bars 4 ins. on centers in both directions, while the beams and diagonal braces are reinforced with ⅞-in. corrugated bars.

Concrete for the support was mixed in the proportions of 1 part Portland cement to 2 parts sand and 4 parts screened gravel. The structure was designed by the engineering department of the railroad and built by the O'Brien Construction Co., of Waterbury, Conn., during the fall of 1908.

Bumping Posts.

A bumping post, to insure safety against rotating or breaking down under constant buffing, must be constructed so as to be anchored in the earth direct rather than attatched to the track itself, as is the case with practically all of the patented posts now in use on railways in this country. By the use of concrete, bumping posts can be constructed economically so as to meet the conditions of stability and permanence.

CHAPTER XI.

Power Stations, Shops, Warehouses and Grain Elevators.

Power Stations.

The electrification of railroad systems, which bids fair to be a thing of the near future, will necessitate the construction of a large number of power stations along the lines of the railroads adopting this form of motive power.

Concrete construction in addition to its low first cost, facility of erection and fireproof character is especially adapted to the building of power plants on account of its inherent strength, resistance to vibration and freedom from deterioration.

The New York, New Haven & Hartford R. R., one of the pioneers in the field of heavy electric traction, has installed electric equipment on its lines from Woodlawn, N. Y., to Stamford, Conn., with the power station for this twenty miles of road located at Cos Cob, about three miles from Stamford. This power house described below is of concrete construction and is a noteworthy example of the pleasing appearance which can be given to a purely utilitarian structure by engineers who pay special attention to the architectural treatment of their designs.

Cos Cob Power Plant, N. Y., N. H. & H. R. R.—The power house is located at Cos Cob, three miles west from Stamford, on the Mianus river, about a mile from Long Island Sound. The engineers in charge of the design and construction of the plant adopted the Spanish Mission style of architecture for the exterior of the building, with a very pleasing result. The interior is divided into a turbine room 60 ft. wide by 112 ft. long, with a switchboard occupying an

additional space of 25 ft. by 110 ft. and a boiler room 160 ft. long by 110 ft. wide.

The foundations, column footings and walls up to the water table are monolithic concrete mixed in the proportions of 1 part Portland cement, 3 parts sand and 5 parts 2-in. crushed granite. All exposed surfaces of the walls have a bush-hammered finish. For the water tables, window arches, coping and window sills, monolithic blocks are used. These blocks are built in special shapes and are made of concrete of the same proportions as the other monolithic work, and have the inner and outer surfaces faced with a mixture of 1 part cement to 2 parts sand.

The walls above the water table are of hollow blocks, 10 ins. by 12 ins. by 24 ins., composed of a mixture of 1 part cement, 3 parts sand and 3 parts 1¼-in. crushed granite, faced on the exterior surface with a mixture of 1 of cement to 2 of sand, and where the inner surface of the wall is exposed, with a mixture of 1 part cement to 4 parts sand. All the window lintels were cast in place, and consist of 1:3:5 concrete reinforced with two ¾-in. trussed bars.

In designing the structural features of the building, the following live loads per square foot were used: Coal bin floor, 550 lbs.; engine room and gallery floors, 400 lbs.; boiler room floor, 340 lbs.; fan room floor, 200 lbs.; roof, 30 lbs. With the exception of the roof slabs, which are of cinder concrete, the stresses allowed for the concrete are 600 lbs. per square inch extreme fiber stress, 400 lbs. per square inch direct compression, and 60 lbs. per square inch shear, and for the steel a tensile stress of 16,000 lbs. was allowed.

The columns in the boiler room are of structural steel, but all other columns in the building are composed of solid concrete blocks made by filling the cored air spaces of the hollow blocks with concrete of the same mixture as the blocks themselves. Over the turbine room, where there are no steel columns, the steel roof trusses are carried by the concrete block wall, the blocks being solid for several courses below the trusses to properly distribute the load. Over the boiler room the trusses are supported in the same way and also by interior steel columns.

The front of the switchboard gallery, at one end of the turbine room, is carried on concrete block columns, which also support a reinforced concrete girder forming one of the crane runways. The latter carry an electric traveling crane, provided with two 17½-ton trolleys. The other crane runway is formed by a similar girder built into the partition wall between the engine room and boiler room, and is carried by pilasters formed in this wall. These girders furnish a rather unique feature, for while they are essentially concrete girders 36 by 36 ins. reinforced with trussed bars, they are built with the bottom slightly arched and the sides and bottoms ribbed to imitate keystone and voussoirs, the whole giving the appearance of a segmental arch.

With the exception of the basement floor, which is 1:3:5 concrete laid directly upon the foundation rock, the floor system consists of concrete slabs, reinforced with twisted steel rods, carried on the top flanges of I-beams. These slabs were mixed in the proportions of 1 part cement, 3 parts sand and 5 parts ¾-in. broken stone, with a 1-in. granolithic finish applied before the underlying concrete had time to dry. After the floors had dried out they were given two coats of linseed oil and lampblack. In the engine room the floor finish is carried up at the side walls and columns to form a base 10 ins. high and 1¾ ins. thick for a 6-ft. wainscoting of Faience tile. Above this wainscoting the walls are unfinished except for a cement wash.

The roof, which has a pitch of 4½ ins. per foot, is of 1:2:4 cinder concrete laid between 3-in. 5½-lb. I-beam purlins 3 ft. on centers, and is finished on the exterior with red Ludowici interlocking tiles set on 1-in. by 2-in. strips 24 ins. on centers, and secured thereto by means of staples and copper wire. Between the tiles and the concrete there is one thickness of tarred paper.

A self-supporting steel stack 13 ft. 6 ins. in diameter and 46 ft. high is carried by the steel columns which support

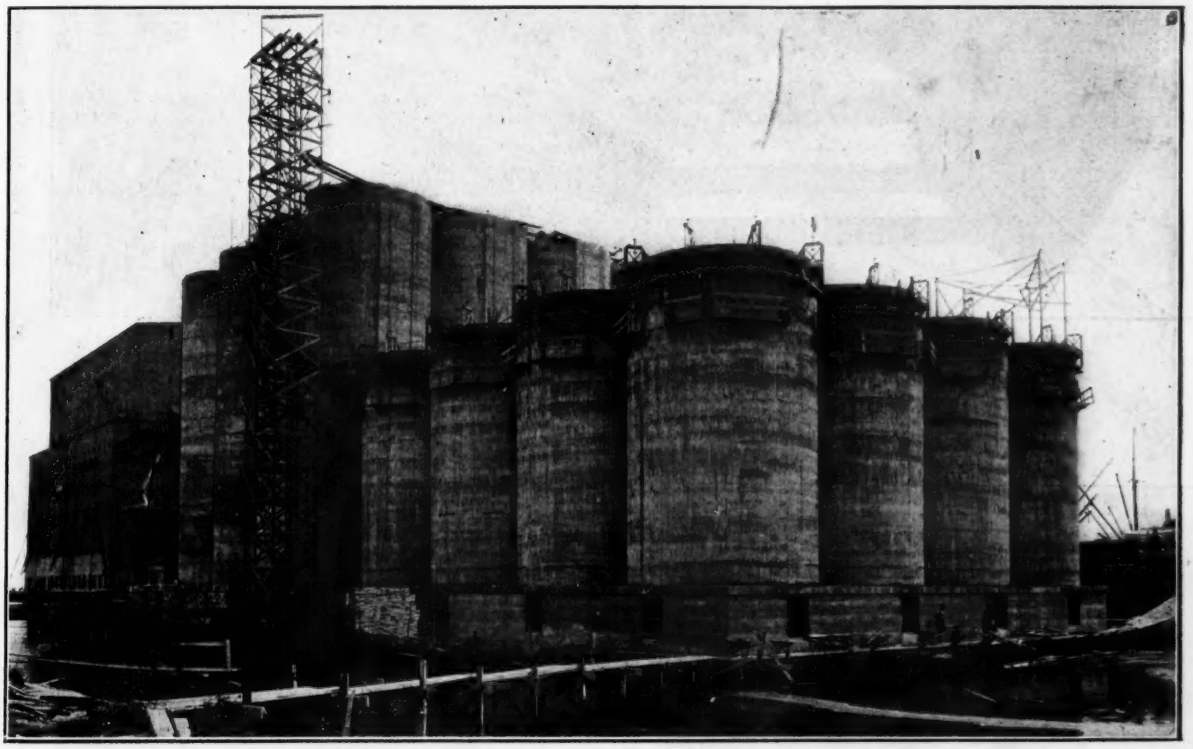


Fig. 40, Grain Elevator Under Construction.

Fig. 38, Water Tank Support, N. Y., N. H. & H. R. R.

Fig. 36, Signal Tower, N .Y., N. H. & H. R. R.

Fig. 37, Grove St. Signal Tower, Hoboken, D. L. & W. R. R.

the fan room floor, thus leaving the space below in the boiler room entirely clear.

Work on the power house was started Feb. 3 and steam was turned on Nov. 4, 1906. The construction plant consisted of one ¾ and one 1½-yard mixers, a stone crusher, 3 boom derricks, a temporary power plant, buckets, etc., and two block machines. The material excavated was a gneiss rock, and furnished a sufficient quantity of screenings to take the place of sand for the exterior walls after crushing and screening all the broken stone for the building. For the wall forms 2-in. matched spruce was used and for the floor and roof slab forms 1-in. matched spruce. The monolithic blocks which were molded in pine forms, well greased, were mixed very wet, and after the removal of the forms were stored under canvas 24 hours and then left in the open for three weeks. After the hollow blocks were turned out of the machine they were cured in the same manner.

The plant was designed, erected and equipped by the Westinghouse Church Kerr Company under the direction of Mr. E. H. McHenry, vice-president of the New York, New Haven & Hartford R. R.

Shops and Warehouses.

The same advantages which reinforced concrete possesses over other materials for the construction of power houses are equally enjoyed by it as a material for shop and warehouse buildings for railway purposes.

Mott Haven Car Shops, N. Y. C. & H. R. R. R.—The Mott Haven shops are 250 ft. long, 43 ft. 10 ins. wide, and they are built in alternate high and low bays, the former 25 ft. high and the latter 19 ft. 4 ins. As windows are provided in each side of the high bays above the roof of the low ones, this construction takes the place of the ordinary saw-tooth roof.

In general, the buildings consist of 2½-in. cement mortar curtain walls reinforced with truss metal lath, No. 28 gauge, resting on a concrete foundation wall rising 4 ft. above the ground level. The roof is carried on light angle trusses supported by I-beam columns placed every 16 ft. 8 ins. at the division between the adjoining high and low sections. Between the columns and window frames steel girts are placed to form a support for the truss metal lath reinforcement of the walls.

The metal lath was kept in place and held rigidly by means of temporary 1 by 1 in. angles spaced about 2 ft. apart. The mortar, which was mixed in the proportion of 1 part Portland cement to 3 parts sand, was placed in the same manner as plaster for an ordinary wall.

The shops were designed and erected in 1908 under the supervision of the engineering department of the New York Central & Hudson River R. R., Mr. G. W. Kittredge, chief engineer. The Truss Metal Lath Company, New York City, furnished the reinforcing material and built the walls of the building.

Newark Warehouse, C. R. R. of N. J.—This mammoth seven-floor warehouse, a photograph of the track side of which is shown in Fig. 40, is 360 ft. long with a width varying from 130 to 165 ft., and has a storage capacity of about 1,200 carloads of freight. The first floor is devoted to teaming, the second to the freight tracks, and the basement and four top floors to storage.

In general, the building consists of a steel frame and concrete walls, with steel columns and girders carrying floor slabs of reinforced concrete. Owing to the presence of quicksand, an exceptionally wide spread of footings was required, which resulted in the engineers making the foundation one continuous plate of concrete 15 ins. thick, reinforced with extra heavy expanded metal.

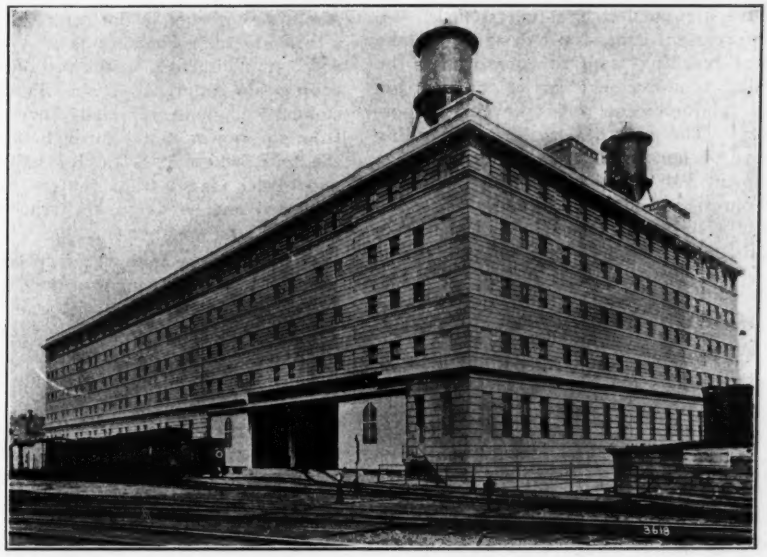


Fig. 40. Newark Warehouse, C. R. R. of N. J.

The walls, which are embellished with rustications, moldings, dentils and cornices, are 20 ins. thick to the second story, 16 ins. thick to the third story, and 12 ins. thick from there to the top. The reinforcement for the walls consists of expanded metal and ¾-in. rods laid horizontally about 4 ft. apart.

The concrete for the walls, floor slabs, column covering and roof slabs, was mixed in the proportions of 1 part Portland cement to 2 parts Cowe Bay washed sand, to 4 parts ¾-in. crushed stone.

The warehouse was designed under the general direction of Mr. Jos. O. Osgood, chief engineer of the C. R. R. of N. J., and constructed by the John W. Ferguson Co., Paterson, N. J., in 1907.

Grain Elevators.

Reinforced concrete is especially adapted to the construction of grain elevators or other structures to be used for the storage of grain on account of its being absolutely proof against fire, water or dampness, dust and vermin, which are all important and essential qualities of the ideal grain elevator.

Grain elevators may be grouped into two classes according to the arrangement of the bins and elevating machinery, viz.: elevators which are self-contained, with all the storage bins in the main elevator or working house; and elevators consisting of a working house which contains the elevating machinery and storage bins connected with the working house by conveyors. Reinforced concrete elevators are commonly built of the latter type, with a working house that is generally rectangular in shape with either square or circular bins connected with the independent storage bins, which are usually circular.

In elevators of this latter type the storage bins are reinforced both horizontally and vertically. The horizontal reinforcement is either single when it is placed in the center of the wall, or double when the bars are placed near the surface. The reinforcement may be continuous, rising from the bottom to the top as a spiral, in which case high elastic limit steel wire is generally used, or it may be placed in separate rings. The vertical reinforcing bars are equally spaced and are wired or clamped to the horizontal rods at intersections.

The horizontal reinforcement is generally designed to take all the tensile stresses resulting from the pressure of the grain, while the vertical reinforcement carries the load between the horizontal reinforcement, and takes its proportion of the vertical load. The walls have a negative bending moment at the points of horizontal reinforcement, and a positive bending moment half-way between the horizontal reinforcement. The pressure on any horizontal section equals the weight of the wall plus the weight of the grain carried by the walls, and this pressure is carried by both the concrete and the steel.

CHAPTER XII.

Storage Reservoirs.

The advent of power construction into the field of railway engineering incidentally introduces another problem for railway engineers in the subject of storage reservoirs for supplying these plants with water.

Reinforced concrete has been used extensively in the construction of reservoirs and when properly designed and constructed is a most suitable material on account of its durability and adaptability to lighter design than common masonry. For large or small tanks it is usually cheaper than steel and requires no repairs.

Reservoirs are built most economically of circular form, and all the tensile stresses must be taken by the steel hoops.

In building water tanks, the materials for the concrete must be very carefully proportioned so as to give a water-tight wall and the stone should be of such size that a good surface can be easily obtained. The proportions used to resist the percolation of water usually range from 1:1:2 to 1:2½:4½, the most common mixture being 1:2:4.

The concrete should be mixed so that it will entirely cover the reinforcing metal and flow against the form. It is absolutely essential that the concreting for the entire tank should be done in one operation, or else that the surface be specially prepared and treated to make water-tight joints.

Cos Cob Storage Reservoir.—In connection with the power plant of the New York, New Haven & Hartford R. R. at Cos Cob, Conn., there is a 564,000 gallon reinforced concrete storage reservoir 80 ft. in diameter and 15 ft. deep. The architectural treatment of the exterior of the reservoir is in keeping with that of the power house and presents a very attractive appearance. As will be seen from the photograph in Fig. 42, the wall has a cornice projecting 13½ ins. and a base 7½ ins., while the flat space between is relieved with a series of forty arched indented panels. To further the effect of these arched panels, the face of the concrete of the indented surface is roughened, and the remainder of the exterior is given a smooth cement mortar finish.

All the concrete was mixed in the proportion of 1 part Portland cement, 3 parts sand and 5 parts ¾-in. crushed granite. The wall is reinforced circumferentially with the cast steel transmission rope, varying in diameter from 1½ ins. at the base to ⅝ in. at the top, forming a continuous spiral with 12-ft. splices made with 16 clips where the ends of different sizes of cable are joined. Wired to the inside of this rope spiral is a continuous sheet of 3 by 12-in. mesh wire cloth, placed in vertical strips and extending 6 ft. into the floor of the reservoir. The wall and floor is waterproofed with 4-ply felt cemented together with a patented compound. On the floor of the tank a 4-in. protective covering of concrete was laid on top of the waterproofing, and carried up the wall 16 ins. at an angle of 45 degs., to form a footing for a 4-in. lining of brick laid up in cement mortar that protects the waterproofing coat of the wall.

A 10-in. inlet and a 12-in. outlet pipe enter through the floor of the tank, and where they pass through the waterproofing, watertight connections are secured by clamping a sheet of soft copper between two flanged screw sleeves. About a foot outside the reservoir wall these pipes run into a concrete valve chamber 11 ft. 4 ins. long, 5 ft. 8 ins. wide and 5 ft. 3 ins. high, in the top of which is a 30-in. manhole having an American Brake Shoe & Foundry Company's standard manhole frame and cover. A 3-in. steam pipe runs from the power house through the valve chamber and into the tank, where it is carried half-way across the floor on small brick piers 6 ft. on centers. This pipe has a perforated upturned end so as to keep the water above the freezing point in cold weather.

In building the tank, the forms for the exterior wall were erected complete from the foundations to the coping. The spiral rope reinforcing was then hung on screw hooks driven into the inner surface of these forms and the wire cloth was wired to the spiral. The inside forms were built up a few feet at a time, and were wired through the vertical supports to the outer forms. The concrete was mixed in a ¾ yard rotary mixer located just outside the reservoir, and was carried inside in 1-yard skips by a guyed derrick placed in the center of the tank and operated by a hoisting engine standing outside. The derrick cables were run through holes in the wall which were filled in after the forms were removed. Two weeks after concreting the walls the forms were removed, the derrick taken out, and the waterproofing was applied as described above.

The reservoir was designed and erected by Westinghouse, Church, Kerr & Co., of New York, the engineers and constructors of the power plant.

Pittsburg Storage Reservoir, Kansas City So. Ry.—This reservoir, 85 ft. in diameter, serves as a storage supply for the Kansas City Southern Railway shops at Pittsburg, Kan. The reservoir rests on a puddle clay bottom, on which a 6-in. cinder fill is placed, and has a concrete wall 4 ins. thick mixed in the proportions of 1 part Portland cement to 2 parts sand to 4 parts broken stone, with a ½-in. 1:1 mortar finish. The total cost of the reservoir, which included 1,500 yards of mass concrete in addition to 66 cubic yards of 1:2:4 concrete, was $736. The Arnold Company, of Chicago, were the engineers in charge of the design and construction.

CHAPTER XIII.

Docks.

Inasmuch as practically every railway system in the country owns valuable water front the question of dock construction is a most important one. The recent terrible fires with their attendant devastation along the water fronts of Hoboken and of Boston have demonstrated only too clearly the absolute necessity of positive fire protection in structures of this nature. The new piers which the Delaware, Lackawanna & Western R. R. have designed to replace those burned down in the Hoboken fire of 1904 are to be built en-

tirely of concrete construction from the cut-off of the piles. This type of pier, which is described below, is proof against fire and decay and should be practically free from maintenance.

In the tropics where the waters are infested with limnoria and teredos which destroy a wooden pile in a few years, and where the very atmosphere itself eats away unprotected wooden and steel structures, reinforced concrete is especially adapted to the construction of wharves and warehouses. Practically all the docks of any magnitude now being constructed in South and Central America and the Philippines, are designed as entire concrete structures.

Hoboken Pier, No. 7, D., L. & W. R. R.—This pier, which is the first of a series to be built on the same general scheme along a railway yard ship canal, is 100 ft. wide and 600 ft. long.

The construction in general consists of a 6-in. concrete floor carried on a cinder fill retained between concrete face walls and supported on a solid timber grillage carried on piles cut off at low-water level.

These piles, which are from 85 to 95 ft. in length, are driven 3 ft. apart in transverse rows 5 ft. apart. Each pile is proportioned for a maximum load of 12 tons. At mean low water they are capped with continuous 12 by 12-in. transverse timbers, drift bolted to them. Spiked to these caps are longitudinal 6 by 12-in. planks laid close to form the deck. On either side of the pier the outer planks alternate with three 12 by 12-in. longitudinal timbers which project above the top of the deck and form ribs to prevent the concrete side walls from slipping or transverse displacement.

The steel shed and platform are carried on concrete piers and longitudinal walls which are built about 11 ft. high to the level of the pier floor.

The space between the side walls is filled with rolled cinders about 9½ ft. deep under the shed and 6 ft. deep outside where the railroad tracks are laid directly on it. The pier shed is 59½ ft. wide and 594 ft. long, and consists of a 6-in. concrete floor without surface finish laid directly on the cinder fill with a superstructure of steel framework carrying reinforced concrete walls and roof.

In connection with the side walls, the provision made to allow for the future adjustment of the walls presents an interesting and important feature in construction of this type where settlement of foundation is liable to occur. The foot of the wall, which is 6 ins. thick, is built in a slot in the concrete floor 6 ins. deep and 7 ins. wide. Two thicknesses of tarred paper separate the wall from the floor thus preventing the possibility of adhesion between the two concrete surfaces, so that the wall, although having a clearance of ½-in. on each side of the slot, is held securely against transverse displacement and forms a closed joint at the bottom, the upper edges of the ½-in. crack being caulked with oakum and pointed with cement mortar.

If settlement occurs, the wall and the steel superstructure will be jacked up to level the roof and the openings on each side of the slot in the floor will be recaulked and repointed, thus restoring the ordinary appearance of the wall.

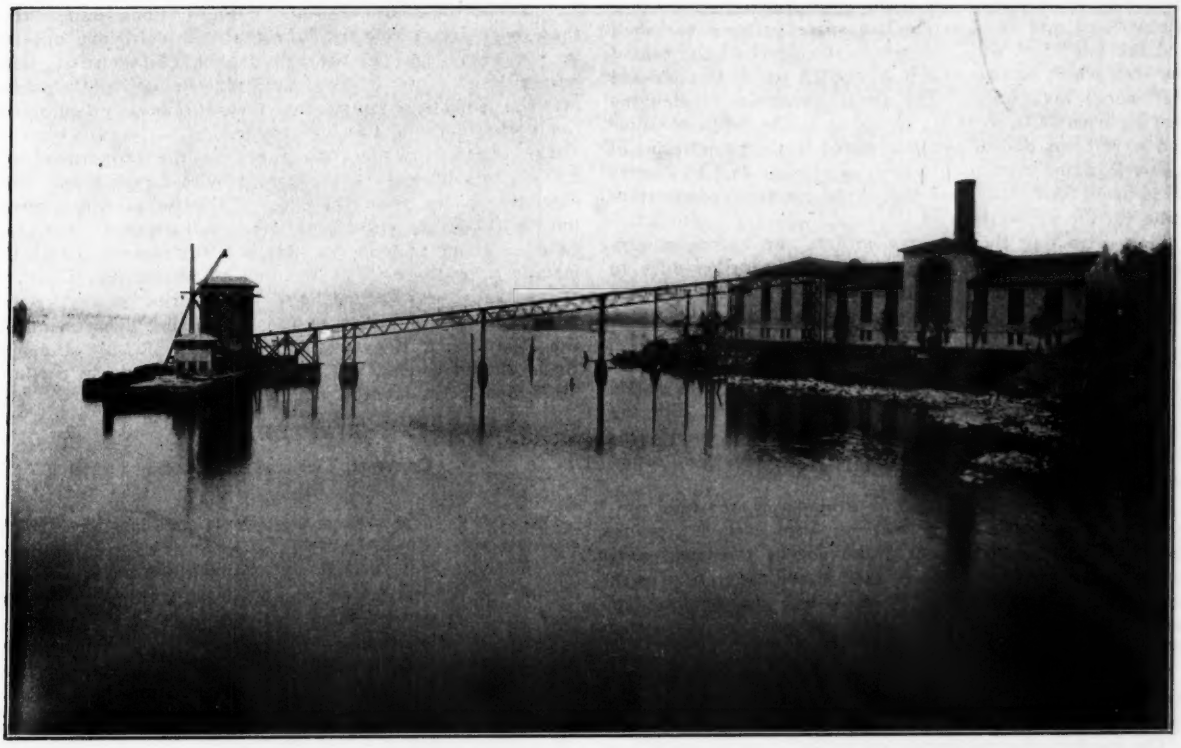


Fig. 39, Cos Cob Power Plant from River.

The shed is divided approximately into equal parts by a transverse reinforced concrete fire wall 12 ins. thick.

The pier and shed were designed by the engineering department of the Delaware, Lackawanna & Western R. R., Mr. Lincoln Bush, chief engineer, and Mr. G. T. Hand, assistant engineer in charge of design, and the general contractor was Mr. Henry Steers, of New York City.

Almirante Wharf, Bocas del Toro, Panama.—This wharf which is at the terminus of the Changuinola R. R., Almirante, Bocas del Toro, Panama, is of special interest owing to the fact that it is of reinforced concrete throughout and that in its construction the problem of pile protection in the tropics has been successfully solved.

It is approximately 700 ft. long and 54 ft. wide and is connected with the main land by a creosoted timber trestle approach about 800 ft. in length. The photograph in Fig. 43 shows one-half of the shore side of the wharf.

As the purpose of the wharf is the loading of bananas onto the outgoing, and the temporary storage of general merchandise received from the incoming, steamers, the front of the wharf for a distance of 23 ft. is open to allow the free use of automatic loading machines, while the remainder is covered with a steel storage shed, open 6 ft. from the bottom in the rear and 14 ft. in the front. The bananas are carried to the loading machines by a 3-ft. gauge track in front connected by cross-overs to two similar tracks running the length of the storage shed. The wharf consists of a series of reinforced concrete columns supporting a system of main girders and cross beams which in turn carry a 7-in. floor slab. The columns rest on wooden piles spaced 10 ft. on centers, protected by a 4-in. covering of concrete.

This method of protecting the wooden piles from the attacks of teredos consisted in driving a 2-in. concrete shell—20 ins. in diameter at the top and 16 ins. at the bottom reinforced its full length with 4-in. by 12-in. wire cloth over the wooden pile and into the harbor bottom two feet. The shell was then sealed at the bottom with concrete, the water pumped out and the intermediate space between the shell and the pile filled with concrete to the level of the top of the shell which was about 2 ft. above the top of the pile and 1 ft. above high water. The shells were made in lengths varying from 32 ft. to 12 ft., according to the depth of water and were composed of concrete mixed in the proportions of 1 part Portland cement to 2 parts of crusher dust to 3 parts of ½-in. broken stone, and the filling consisted of concrete mixed in the proportions of 1:2:4.

In constructing the columns, girders and beams, a mixture of 1 of cement to 2 of sand to 2 of crusher dust to 3 of 1-in. broken stone was used and for the floor slabs a mixture of 1:2:1:3 of the same materials.

The reinforcing rods for the columns were embedded in the filling between the shells and the piles and were carried up through the main girders and into the floor slab, thus securely tieing together the entire structure. For the columns, main girders and railroad beams, ⅞-in. round rods were used for reinforcing, and for the floor slab, ½-in. round rods.

The ship buffer consists of two 8 by 12-in. creosoted timbers protected by 2 by 10-in. wearing strips every 3 ft. 4 ins. and a railroad car spring of 19,000 pounds resistance, resting in a cast steel socket embedded in the concrete at each bent to take the shock. Every 50 ft., hollow steel mooring bits were placed on, and bolted to concrete pedestals and were then filled with concrete.

With the exception of the general foreman, native and Jamaican labor was used throughout, both for building the forms, placing the concrete and erecting the steel shed.

The mechanical equipment consisted of a stone crusher, a ¾-yard rotary mixer with hoist, a floating pile driver with a No. 3, 4,500-lb. steam pile hammer, 6 charging carts, an improvised machine for bending the rods cold, and a number of narrow gauge cars on which the shells were made.

The wharf was designed by Mr. T. Howard Barnes with Mr. J. R. Worcester as consulting engineer, and was constructed under his supervision in the fall of 1907 and the winter of 1908, with Mr. Chester S. Allen as resident engineer and Mr. Robert V. O'Brien as superintendent for the United Fruit Company.

CHAPTER XIV.

Tunnels and Tunnel Lining.

One of the most common uses of both plain and reinforced concrete is in the construction of tunnels and subways. The term tunnel as generally understood by railway engineers is applied to construction under cover, in which the tunnel bore is advanced by drifting, the surface of the ground above the work not being disturbed. The term subways is applied to open cut construction. A tunnel for heavy and fast railway traffic should be built with the entire lining, and for still greater economy with the roadbed of concrete. The old Bergen Hill tunnel, on the Lackawanna Railroad, is lined with brick for a portion of its length, and fourteen men are at work every night in the year inspecting the lining and repairing the track. This expensive and dangerous maintenance work, which costs annually approximately $6,000, is practically eliminated in the new tunnel, described on a following page, which is built with the entire lining and roadbed of concrete.

New Bergen Hill Tunnel, D., L. & W. R. R.—This tunnel is 30 ft. wide in the clear, 23 ft. 5 ins. high from the base of the rail to the crown of the roof arch, and has a concrete lining of a minimum thickness of 2 ft. The length of the tunnel is 4,280 ft. and at two points located at about one-third the length of the tunnel from each portal it is connected to the old tunnel, which is immediately alongside the new one, by an open cut extending across the four tracks, 100 ft. long and 80 ft. wide.

At about the center of each of the sections, into which these open cuts divide the tunnel, shafts 10 ft. long and 30 ft. wide were sunk to the new tunnel. These shafts and open cuts were used to good advantage in moving the waste material from the headings and they also greatly facilitated the work of placing the concrete lining.

The concrete, which was mixed in the proportions of 1:2½:5, was placed so as not to require tamping and was carefully spaded from the face of the forms which were lined with No. 20 gauge sheet steel well greased. This resulted in giving the exposed surface of the concrete a smooth metallic appearance which required no further finishing.

The tunnel was designed and built, during years 1906 to 1908, under the direction of the engineering department of the Delaware, Lackawanna & Western R. R., Mr. Lincoln Bush, chief engineer, and the lining was put in by Arthur McMullen & Co., contractors, New York.

CHAPTER XV.

Concrete Ties and Roadbeds.

Ties.

One of the most serious and perplexing questions which confronts the railroad engineer of today is the tie problem. As an evidence of this, during the year 1907 the railroads of the United States used approximately 118,000,000 ties, a very large percentage of which were renewals.

This vast inroad upon the limited and rapidly decreasing supply of timber has caused wooden ties to become poor in quality and high in price, with a result that railroad engineers realize the necessity of procuring a substitute and have been experimenting with concrete ties of various designs for the past few years. While none of these ties have been tested long enough under heavy and high speed traffic to warrant selecting any one as a proper substitute for the wooden ties under all conditions, the success of some of the ties tested thus far has been great enough to convince railroad engineers who have given the most study to the subject, that a properly reinforced concrete tie with proper fastenings is a practical and economical tie, at least for tracks where the speed is low and where conditions are adverse to the life of wood or metal. Concrete ties are suitable for use in yards and sidings and there is an enormous place for their introduction into this field alone.

Concrete ties possess certain natural advantages over either timber or steel inasmuch as dampness, drawn fires and insects have absolutely no effect upon them. In addition, they are practically independent of the steel and timber market, and can be made along the line of the railroad, and, as compared with the chemically treated timber or the steel tie, at a reasonable cost.

Concrete ties have been in successful use in Indo-China for about ten years, where a very peculiar species of ant

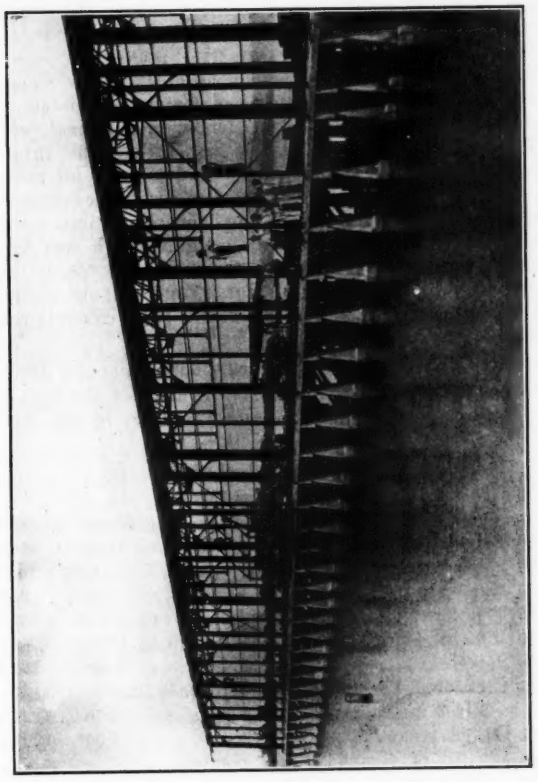


Fig. 43, Almirante Wharf, Bocas Del Toro, Panama.

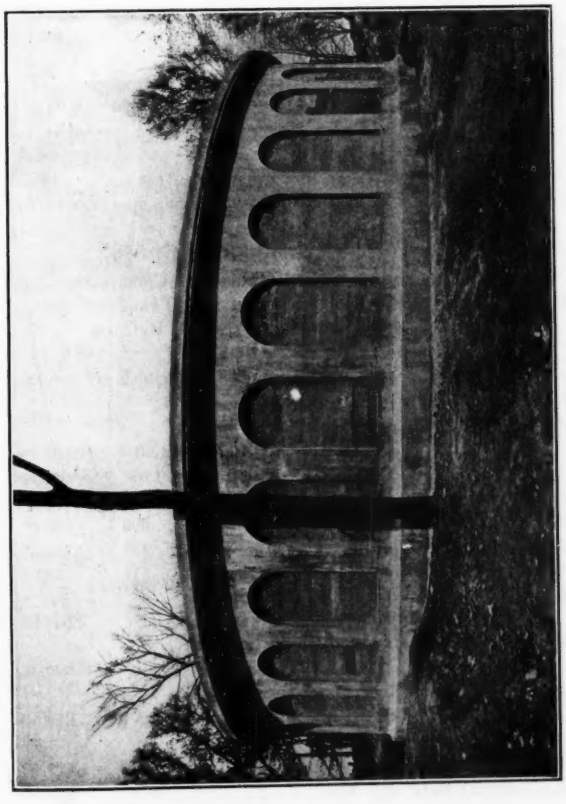


Fig. 42, Cos Cob Storage Reservoir, N. Y., N. H. & H. R. R.

destroys wooden ties in a few months. At the present time it is estimated that there are over 1,000,000 of these ties in service. They are of an inverted T-section, the flange of which is laid on the ground, the stem being vertical. The rails are fastened by bolts which are imbedded in an enlargement of the stem where the rails pass. In Italy concrete ties have been tried with such success that the Italian government has recently placed an order with various manufacturers in Italy for 300,000 concrete ties.

In the design of a successful tie there are a number of important functions that seem to be more or less overlooked in many of the ties thus far built. Cushion blocks, if used, should be removable, and the fastenings should be of such a nature that they will never have a tendency to shake loose nor be inaccessible, and may be renewed if injured.

Inasmuch as automatic block signaling is being extended very rapidly upon practically all of the railroads, it is important that the rails should be insulated, and therefore it is necessary to place sufficient concrete between the metal in contact with the rails and the longitudinal reinforcement.

Many long ties have failed from the fact that they were not designed to act as cantilever beams, thus being unable to withstand the severe shocks coupled with the sinking of the tie under passing loads on center bound track. The difficulty experienced with tie blocks has been in keeping them in longitudinal position and maintaining them so that the vertical deflection of one rail will not greatly exceed that of the other, thereby causing rolling and pounding of the equipment.

Finally, ties should be of sufficient strength to support derailed cars and engines until they are off the ends of the ties and actually into the ditch; otherwise, an ordinary derailment may become a serious wreck.

Concrete Roadbeds.

While the original cost of a solid concrete roadbed is greater than the ordinary cross-tie construction, it is undoubtedly more economical in the end for tunnels and subways; especially so where space is cramped, traffic heavy, and a track cannot be temporarily abandoned, and where with the running rails, guard rails and third rails attached to the long ties—as in the case of electrified lines—it is extremely difficult and very expensive to maintain and tamp up track to surface and make tie renewals.

Also, it can be used to great advantage and economy in rock and earth cuts where there is always a large maintenance expense to keep ditches open and track in good surface.

In addition to the question of ultimate economy, the solid concrete roadbed is especially commendable for tunnel and subway construction from a hygienic standpoint; for in most tunnels and subways ventilation is difficult and the accumulation of grease, dirt and debris, which is readily held by the ballast of the cross-tie track construction, is a serious menace to the health of the passengers. This can be eliminated in the solid concrete construction, as the entire roadbed can be flushed with water and kept in a neat, clean and sanitary condition.

Roadbed Construction of the New Bergen Hill Tunnel, D., L. & W. R. R.—This construction consists of a roadbed of concrete laid on the rock bottom of the tunnel with 8 by 8 in. creosoted timber tie blocks 2 ft. 6 ins. long set in the concrete and spaced 1 ft. 10 ins. from center to center, for supporting the rails. These tie blocks have a notch at the outer end to form a shoulder, and are set when the concrete is put in. The concrete fills the space made by the notch in the tie block, and prevents the lateral shifting of the block and railroad rail; the rail is fastened with lag screws and wrought iron clips. A tapered creosoted wedge block holds the tie block tight against the concrete, and can be driven in to take up any looseness due to shrinkage or wear. The wedge is held in place by a lag screw extending about 2 ins.

into it through the guard rail. The guard rail is fastened to the tie blocks by lag screws, and is also anchored to the concrete by anchor bolts.

To replace the tie blocks, the lag screws are removed, the wedge withdrawn, the tie block moved forward until the shoulder of the block clears the shoulder in the concrete, and the tie block is then pulled out laterally without disturbing the adjacent tie blocks or rail fastenings and without raising the rail, thus not interfering with traffic.

One man can replace these tie blocks and wedges, while with the ordinary type of ballast track construction it is necessary for a gang of men to dig out the ballast in order to replace a tie, and it also is necessary to protect traffic while the work is being done.

The proportions used in the track superstructure were one part of cement to 6 parts of Cowe Bay gravel and sand, and in the sub-base the proportions were 1 part of cement to 12 parts of crushed stone and sand for bringing the sub-base up to proper level.

The table below gives an estimated cost of the ballasted roadbed construction for double track. So far as the amount of tunnel excavations and the cleaning up of muck under the roadbed are concerned, the cost would be the same whether ballasted track or concrete roadbed were used, but with the concrete roadbed the tile drains and trenching for ditches for the drains are eliminated. The estimated total cost, including the conduits, tile drains, creosoted ties, etc., as detailed, for the ballasted double track, for a length of 4,280 ft. amounts to $62,568.87, which would be at the rate of $14.62 per lineal foot of double track. If the conduit construction is eliminated from consideration, the total cost amounts to $43,429.87, or $10.15 per lineal foot of double track.

Below is given a detailed statement of the actual cost of the concrete roadbed construction, which does not include any estimate for the concrete sub-base under the finished track superstructure. The statement in detail shows the actual cost for 4,280 lineal feet of double track as taken from the company's invoices and records. It will be noted that this statement includes the two lines of 12-hole conduits.

The railway furnished sand, stone and cement for the concrete work, and the price of $6.25 per cubic yard in the detailed statement for concrete roadbed includes the contractor's price, plus the cost of material. The contract provided that the contractor would lay the conduits, the railroad company to furnish the material, and the contractor to receive the same price per cubic yard for the work as he received for the balance of the concrete work for tunnel lining, namely $3.50 per cubic yard. This price of $3.50 per cubic yard included everything excepting sand, stone and cement. The company assembled the tie blocks and rail and the cost of these items is included in the detailed statement. The cost thus figures $14.26 per lineal foot of double track. Eliminating the conduit construction from consideration, the cost per foot of double track for concrete roadbed amounts to $13.18 per lineal foot of double track, as against $10.15 per lineal foot of ballasted double track. Had the conduits been eliminated from the concrete roadbed construction, the superstructure could have been made about 4 ins. less in height, which quantity would have practically made up for the area of concrete occupied by the conduits.

So far as the maintenance cost is concerned, the concrete roadbed construction has resolved itself into a question of simply track inspection, and one inspector during the night and one during the day is all that is necessary. When a tie block must be renewed, it can be done without disturbing in any way the rail fastenings to the tie blocks on either side of the one to be renewed, and no removal of rail will be necessary. One man can readily replace a tie block 8 inches by 8 inches by 2 feet 6 inches, and no interference whatever would occur with traffic during such renewal, as an inch board could be placed underneath the rail on top of the concrete, either side of the block to be renewed, for temporary support.

Still another detailed statement is given below showing the actual cost to the company per annum to maintain ballasted track in the present old Bergen Hill Tunnel, which is of the same length as the new tunnel, the traffic through it being very heavy. Capitalizing the investment for ballasted track construction and for concrete roadbed construction (including conduits) at 4 per cent, and taking into consideration the difference in cost of maintaining, it was found that the saving per annum in cost per mile of double track (with conduits) amounts to $7,107.32, and without conduits the saving per annum per mile of double track concrete roadbed would be $6,389.42.

Estimated Cost of Ballasted Track Construction for Double Track Through New Bergen Hill Tunnel of the Delaware, Lackawanna & Western R. R. at Jersey City, N. J.

Length of tunnel—4,280 feet.

232	Gross tons 91-lb. special open hearth rail	@	$34.00	$7,888.00
520	Pairs of angle bars	@	1.07	556.40
3120	Splice bolts	@	.03⅓	104.00
3120	Nut locks	@	.009	28.08
8835	Tie plates, 6 in. x ½ in. x 9 in.	@	.131	1,157.38
520	Joint tie plates, 6 in. x ½ in. x 11 in.	@	.171	88.92
18710	Spikes	@	.01¼	327.40
4677	Creosoted Y. P. ties, 7 in. x 9 in. x 8 ft. 6 in.	@	2.10	9,821.70
6737	Cu. yd. stone ballast, delivered	@	1.00	6,737.00
17976	Lin. ft. of vitrified 6-hole conduits, 5 per cent allowed for breakage	@	.225	4,044.60
5720	Yd. drilling for wrapping conduit joints	@	.095	543.40
2035	Cu. yd. rock excavation for tile drains	@	7.00	14,245.00
8988	Lin. ft. 8-in. drain tile, 5 per cent added for breakage	@	.085	763.97
2000	Cu. yd. of extra concrete for conduits	@	6.25	12,500.00
8560	Lin. ft. single track lay'g and surfac'g	@	.20	1,712.00
586	Cu. yd. concrete voids occupied by conduit	@	3.50	2,051.00
				$62,568.87

$62,568.87 ÷ 4280=$14.62 per foot of double track.

If conduits are eliminated from consideration, cost would be $43,429.87.

$43,429.87 ÷ 4280 = $10.15 per foot of double track.

Details of Actual Cost of Concrete Roadbed Construction for Double Track Through New Bergen Hill Tunnel of the Delaware, Lackawanna and Western Railroad at Jersey City, N. Y.

Estimate includes electric wire conduits. Length of tunnel, 4280 feet.

232	Gross tons 91-lb. special open hearth rail	$34.00	$7,888.00
520	Pairs of angle bars	1.07	556.40
3120	Splice bolts	.03⅓	104.00
3120	Nut locks	.009	28.08
8835	Tie plates, 6x½x9-in	.131	1,157.38
520	Joint tie plates, 6x½x11-in.	.171	88.92
17976	Lin. ft. vitrified 6-hole conduit, 5% allowed for breakage	.225	4,044.60
5720	Yd. drilling for wrapping conduit joints	.095	543.40
9360	Creosoted yellow pine tie blocks, 8-in. x 8-in. x 2 ft. 6-in.	45.00	5,616.00
9360	Creosoted yellow pine wedges, 2¼ in. x 8-in. x 2 ft. 6-in.	45.00	1,579.50
17680	Intermediate rail clips	.039	689.52

18720	Pieces round iron 1-in. x 15-in. for reinforcement	.06⅓	1,185.60
1040	Joint rail clips	.051	53.04
18720	Lag screw spike, ⅞-in. x 7½-in.	.046	861.12
9360	Lag screws for guard rail, ¾-in. x 11-in.	.034	318.24
9360	Washers for guard rail, ⅜-in. x 3-in.	.03	280.80
9360	Wedge lag screws, ½-in. x 7-in.	.013	121.68
18555	Lin. ft. of Y. P. creosoted guard rail, 5-in. x 8-in.	45.00	2,783.25
4680	Guard rail anchor bolts, ⅞-in. x 18-in.	.08⅜	405.60
4680	Guard rail washers, ⅜-in. x 3-in.	.03	140.40
4680	Anchor nuts, 2¼-in. sq. x 1¼-in. thick	.08	374.40
4680	Paraffine tubes for anchor bolts	.005	23.40
3754.4	Cu. yd. concrete	6.25	23,465.00
1019.2	Cu. yd. concrete voids occupied by tie blocks, wedges and conduits	3.50	3,567.20
	Labor and engineering for assembling and fastening complete, the tie blocks, wedges, guard rail, rail, rail joints, screws, spikes, etc., 8560 lin. ft.	.60	5,136.00
			$61,011.53

$61,011.53÷4280 = $14.26 per linear foot of double track with conduits and wrapping.

$56,423.53, total cost, exclusive of conduits.

$56,423.53÷4280=$13.18 per linear foot of double track.

Cost Per Annum. Ballasted Track. (With Conduits)
$62,568.87, @ 4% ..... $ 2,502.75
Track maintenance,
$565.00 per mo. x 12 ..... 6,780.00
Length of 4280 ft ..... $ 9,282.75
$9,282.75 × 5280/4280 ..... $11,451.57 per mile

Cost Per Annum. Ballasted Track (Without Conduits)
$43,429.87, @ 4% ..... $ 1,737.19
Track maintenance,
$565.00 per mo. × 12 ..... 6,780.00
Length of 4280 ft $8,517.19
$8,517.19 × 5280/4280 ..... $10,507.20 per mile

Cost Per Annum. Concrete Roadbed (With Conduits)
$61,011.53, @ 4% ..... $ 2,440.46
Track maintenance,
$90.00 per mo. × 12 ..... 1,080.00
Length of 4280 ft $3,520.46
$3,520.46 × 5280/4280 ..... $ 4,344.25 per mile

Cost Per Annum. Concrete Roadbed. (Without Conduits)
$56,423.53, @ 4% ..... $ 2,256.94
Track maintenance,
$90.00 per mo. × 12 ..... 1,080.00
Length of 4280 ft ..... $ 3,336.94
$3,336.94 × 5280/4280 ..... $ 4,117.78 per mile

This roadbed construction was designed and patented by Mr. Lincoln Bush, who was at the time Chief Engineer of the Delaware, Lackawanna and Western Railroad.

RAILWAY CONSTRUCTION.

It is stated that the Southern Pacific will start work on the Fernley-Lassen branch across the Pyramid Indian Reservation as soon as the right of way is granted by the U. S. Government.

The Central of Georgia is preparing plans for a gravity system for handling freight between the docks and warehouses at Savannah, Ga.

Reed & Stem, Architects, 5 E. 42d St., New York City, are working on the plans for a new station to be erected at Detroit for the Michigan Central. The general outlines only have been decided upon.

The Chicago, Milwaukee & St. Paul has given contracts to the Bates & Rogers Construction Company, for the grading work, also for constructing subways and bridges required for the construction of lines and terminals in the city of Spokane, Wash.

The Chicago & Northwestern has been purchasing land at Peoria for its large terminal yards, which will be built in connection with the new line to the coal fields in Southern Illinois.

According to reports, the Great Northern is planning to build about 200 miles of feeder lines in the eastern part of the state of Washington. A line is to be built from Republic, south along the San Poil river to Hell Gate, thence following the Columbia river to Peach, and from that point to a connection with the main line at Bluestem, about 100 miles. It is probable that line will also be built north up the east bank of the Columbia river from Peach to Marcus—90 miles.

The Memphis, Dallas & Gulf, A. M. Van Auken, Chief Engineer, Nashville, Ark., has acquired the Caddo & Choctaw and the Hot Springs, Glenwood & Western Rys., two short lines. The Memphis, Dallas & Gulf is projected to run from Hot Springs and Memphis to Dallas. With the purchasing of the two short lines and the connecting of the several roads there will be a route owned by the Memphis, Dallas & Gulf from Hot Springs to Ashdown, Ark. Plans are being made for an extension from Ashdown to Dallas.

The St. Louis & San Francisco is to lay 18,000 tons of steel rails on the Louisiana Southern, which has been leased. It is understood that about $1,000,000 will be expended for improvements.

Extensive betterment work is planned by the International & Great Northern which will probably be undertaken as soon as the State Railroad Commission names the valuation of the road and the money on bonds is obtainable. Among the greatest improvements will be the placing of new steel on about 250 miles of track.

The Manatawney R. R. expects to let contracts soon to build from a point near Douglassville, Pa., north to Spansville, 10 miles. The approximate fill per mile is 15,000 cu. yds., approximate cut per mile is 10,000 cu. yds., and the maximum grade will be about 1 per cent.

Patton & Gibson Construction Co. has been awarded the contract for the grading for ten additional tracks at the Ray yards of the Missouri, Kansas & Texas west of Denison. Narrow gage engines, cars, steam shovels and other equipment have been shipped from Gap, Okla. As soon as the grading is completed, which will be in about three months, the Katy will put a force at work laying track.

The Pennsylvania R. R. has made surveys through the residence section of Rushville, Ind., for a new right of way which will do away with some of the curves in its present line.

The Charleston & North Western will award contracts some time next spring to build from Mt. Pleasant, S. C., northeast to McClellansville, 32 miles; Bonneau to Gueerins Bridge, 30 miles, and Cainhoy to Guerrins Bridge, 6 miles. There will be one steel bridge, also a number of terminal stations and way stations.

The Signal Department

SIGNAL STANDARDS NO. 21, THE NORTHERN PACIFIC.

The first use of automatic block signals on the Northern Pacific Ry. was in 1907. This company is using both upper and lower quadrant semaphore signals with a stroke of 45, 60 and 90 degrees. The signals are operated by an electric motor with the mechanism located either at the top or bottom of the post. Night color indications are green for clear, yellow for caution, and red for stop. Soda and gravity batteries are used to furnish current, and the same battery is used for line circuits and signal operation. The average length of a track circuit is 3,500 feet. Relays are of various types and have a resistance of 4, 9 or 16 ohms. No automatic stops are in use; overlaps are used on single track. Separate pole line is not provided for signal circuits; line wire is No. 10 copper clad. Common return circuit is broken about every 10 miles. Wire ducts are wooden, and above ground. The size and type of wire for bootlegs is No. 10 B. & S.; leads from track No. 10 B. & S.; leads from line No. 14 B. & S.; leads from battery No. 14 B. & S.; in chutes No. 10 flexible. Semaphore switch indicators are used on double track except in busy yards. These are either upper or lower quadrant, not illuminated at night. Bracket posts are used where required.

ALTERNATING CURRENT SIGNALING APPARATUS,* CHEMNITZ-HILBERSDORF SORTING YARD, GERMANY.

By E. Besser.

At the Chemnitz-Hilbersdorf sorting yard two new sets of signaling apparatus were put in operation at the beginning of 1910; they are operated by strong current, namely by single-phase current which is obtained from the electric-light installation existing at the yard. In selecting the system of operation, signaling apparatus operated by direct current from an accumulator battery was also taken into consideration; this is probably now the most usual system and has already given good results in the case of other signaling aparatus already existing at the same yard. In the latter case it had however been found to be a disadvantage that this signaling apparatus, whose action depends on the position of a small soft-iron armature in the field of a direct-current electromagnet, only works reliably if the current has the necessary strength of 1 ampere; the battery consequently requires much attention. In addition the renewal of the battery, which had to take place about every two months, resulted in working expenses of about 150 marks (£7.10s.) per year. It was hence decided to use strong current for the two new sets of signaling apparatus. As alternating current was alone available, and as the use of a rectifier appeared to be too complicated and inadvisable for several reasons, signaling apparatus operated by alternating current was obtained, constructed by the German Telephone Works Company of Berlin.

Alternating current of about 50 volts and 50 periods is taken from the nearest switchboard of the lighting installation of the yard. This current is led by means of two two-wire cables to the two transmitters. Each transmitter is connected with its receiver by means of a five-wire cable. When the lever or handwheel of the transmitter is turned, this movement is transmitted in a way which will be described later on to the cam spindle shown in figure 1, and the contact makers 1, 2 and 3 are closed in succession. The three spools of the receiver, set at angles of 120 degrees to each other, thereupon receive current in succession and their movable iron cores are drawn into the spools in the same order. The to-and-fro movement of the three iron cores is converted by means of connecting rods acting on one common crank into a rotary movement which is transmitted by toothed wheels to the pointer spindle of the receiver.

At each operation an alternating-current bell is sounded at the transmitter and a buzzer at the receiver. The bell signal informs the operator at the transmitter that the current required to operate the receiver is working correctly. The buzzer in the signal cabin can also be operated from the transmitter without any signaling operation by pressing down the button T^1. In order to make it possible to give a bell signal in the reverse direction, from the signal cabin to the rail brake, for instance should it be required to interrupt the shunting of the cars, a button T_2 is provided in the signal cabin and connected with the bell at the transmitter by means of the fifth wire in the cable.

The arrangement of the transmitter is shown in figure 2. When the lever or handwheel a_1 is turned, the pointer of the transmitter is moved into the position desired, by means of a gearwheel transmission (ratio 1 : 1) not shown in the figure. The star wheel a_3 moves with the lever, to which it is fixed. When the pointer has been moved one division the pawls h_1 and h_2 have taken into the next gaps between the teeth, and this places the pointer truly central to the field. The movement of the transmitter is transmitted to the cam spindle mentioned above, by the pairs of spur wheels d_2e_1 and e_2f_1, and the gear is such that the cam spindle makes one complete revolution when the pointer advances one division. The speed of the rotation of the cam is, however, reduced by the anchor escapement f_2g, so as to enable the contact makers to remain closed for a sufficient length of time. In order, nevertheless, to make it possible to give the signals quickly enough, a spring is inserted between the transmitter lever and the wheels. The carrier pin a_2 is fixed to the lever, the pin d_1 to the toothed wheel d_2. The two arms b and c are pressed against these pins by a powerful spiral spring. When the transmitter lever is turned in the direction indicated by the arrow, the arm b is at once moved into the end position and the spring becomes strained. The energy stored up in it then gradually acts on the gearing, the arm c moving the pin d_1, until it is again in contact with arm b. The interposition of the spring makes the speed of rotation of the cam spindle independent of the quickness with which the lever is operated. However quickly the latter is moved, the spindle turns with a nearly constant speed, depending chiefly on the inertia of the anchor escapement. Consequently failures due to too short duration of contact are excluded. On the cam shaft there are one double and two single cams, set at 72° to each other, so that contact maker 1 is closed twice during each complete revolution of the cam shaft, and contact makers 2 and 3 once each. The contact makers are of the spring carbon type, and open in the state of rest. They are closed in the order 1, 2, 3, 1 or in the order 1, 3, 2, 1, according to the direction in which the transmitter lever is moved.

As the spools of the receiver receive current in the same order, the crank spindle of the receiver is always turned in the same direction as the cam spindle of the transmitter. By using a magnet coil of suitable shape and design (fig. 3) a strong pull is obtained with comparatively few ampere-turns, so that a current for 0.1 second suffices in order to draw with

*From the Bulletin of the International Railway Congress.

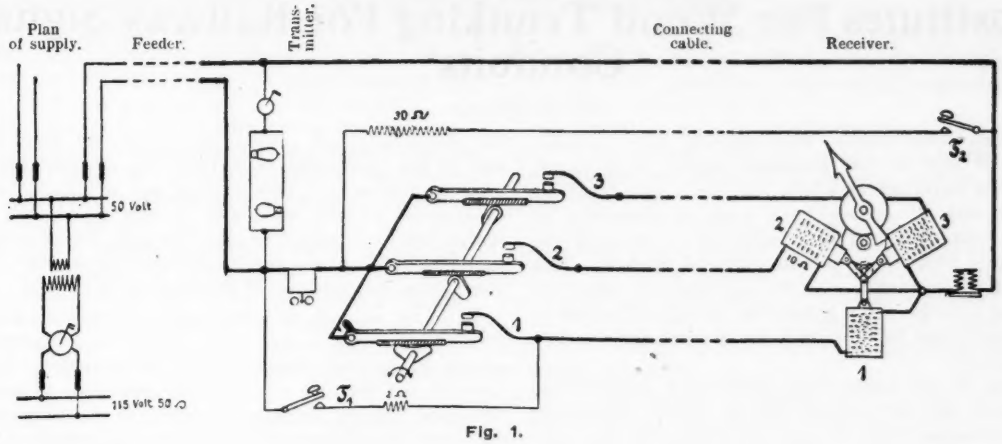


Fig. 1.

certainty the iron core into the spool. The rotation is transmitted from the crank spindle to the pointer spindle by toothed wheels. It is to be noted that this connecting-rod drive makes any injurious swinging which might send the pointer too far, impossible, as the sum of the accelerating and retarding forces of the iron cores which move forward and backward are equal to zero in every position of the crank. The small inertia of the pointer, which only moves at a slow rate, is wholly counteracted by the fact that at the end of each revolution of the cam shaft spool 1 is excited. For this brings the crank spindle into that position which it tends to assume under the action of the weight of the iron cores. The pointer of the receiver, therefore, is always exactly in the middle of a field. In order to make it possible in a very simple manner to adjust the pointers of the transmitter and the receiver so as to be in the same field, stops for the pointer are provided at each end of the divisions of the receiver. Consequently, it is only necessary to turn the transmitter lever once into the one and once into the other end position. The adjustment of the receiver is then effected automatically.

The use of strong current also makes it possible to have a good illumination of the transmitter which is in the open, reliable even in stormy weather. In it there are two glow-lamps, which illuminate the transparent dial. In order to prevent the employe operating the transmitter from being dazzled by the bright dial, ordinary 115-volt carbon-filament lamps are used, which with the 50 volts used only become red hot.

The consumption of the receiver is about 30 watts. As the apparatus requires current for short moments only, the cost of current for each apparatus only amounts to about 3 marks (3s) per year. This, of course, assumes that the apparatus can be connected, as it is at Chemnitz, with a power line live even in the daytime. If power has to be supplied for the purpose, this adds to the cost.

The operation of the transmitter is easy, as the pointer is brought into the position desired by one simple turn of the transmitter lever or handwheel, not by turning a crank several times. The transmission of the signal is also certain, as the anchor escapement provides for closing the contacts for a sufficient length of time, which is always the same. If the pointer of the transmitter is moved from one end position into the other, that is through 14 fields, the position of the receiver only reaches the end position about seven seconds later, as the cam spindle wants about this time to make its fourteen revolutions. In spite of this no trouble has arisen, owing to the small distance between the rail brake and the switch which is taken from the facing side, as the car stopped at the rail brake requires more time before it has again run off the skids. When the car leaves the rail brake, the switchman has accordingly already received the signal and has had time to set his switches. This would still be the case if the transmitter had considerably more fields.

Transmitter and receiver are both fixed to the movable covers of their cast iron casings, so that all parts are readily accessible. All parts subject to wear are arranged so as to be easily replaceable.

The two sets of signaling apparatus have been in use day and night ever since January, 1910, and have up to the present worked satisfactorily. In particular, the carbon contact makers have given no trouble.

The receiver can, if necessary, be supplemented with an additional pointer, indicating the last but one signal. In that case the cable between the transmitter and the receiver requires another conductor. This was, however, unnecessary in the case of the Chemnitz installation, as owing to the short distance between the rail brake and the signal tower any order given is as a rule finished and done with before a new order arrives.

The signals can also be sent from one rail brake to several signal towers simultaneously. The corresponding spools of the receivers are then connected with the three conductors going to them, and the buzzers with the return.

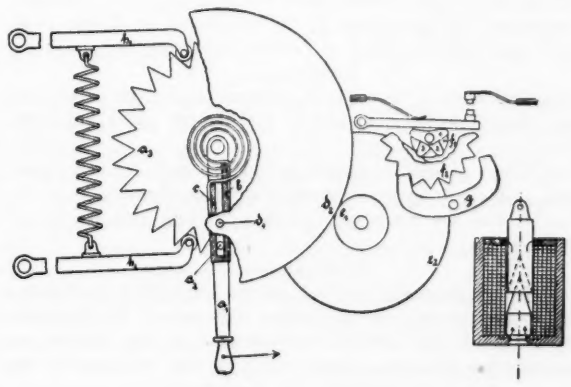


Fig. 2.

Fig. 3.

Count that day lost,
Whose setting sun,
Sees not a batch
Of concrete run.
—Author Unkown.

Substitutes For Wood Trunking For Railway Signal Conduits*

W. K. Sparrow

Underground cable systems have recently been installed in connection with several important signal installations, the permanent character of which, and the necessity of insuring continuity of service have made it necessary to adopt some better method of housing and protecting the circuits than is afforded by the use of wood trunking. The high cost of wood trunking and its comparatively short life have created a demand for a material or a combination of materials which can be developed for general railway conduit construction.

The object of this paper is to suggest for consideration other materials that may be substituted, and not to recommend any particular class or type of conduit. At the present time possibly no one class or type, as manufactured, would be considered suitable to meet all the existing conditions.

The electric light and telephone companies throughout the country were probably the first to place their wires underground. They did so not only for protection against injury to person, but because better service could be given and because of the reduction of maintenance charges of underground as against overhead construction. A history of their progress in underground construction will bring out, perhaps, as well as any other comparison, the various classes and types of conduits.

The original subway was of the class called troughing. It consisted of wooden boxes laid in the earth. The wires were laid in these boxes, covers nailed on and the earth filled in around them. This was what is known as a solid troughing system. This system developed much trouble, due to the fact that the ducts were not waterproof, and allowed moisture to enter, causing decay of the wood as well as the short-circuiting of the wires. This is the same system that is still being used in connection with railway signals.

The next step in advance was made by filling in this troughing with a compound of tar or other similar material. This was a slight gain in the protection of the wires, but had the disadvantage of not allowing an increase in the number of wires, or a change in the size of the conductors, unless the earth was excavated, and the subway reconstructed. Another disadvantage was that the compound would run out leaving the wires exposed to moisture.

About twenty-five years ago advancement was made by the use of the Edison tube system. These tubes were made of iron pipe in 20-foot lengths, and placed in them were semi-circular copper conductors, which were wrapped individually with rope and held together by another layer of the same material. After being placed in the pipe compound was forced in and the ends sealed with wooden plugs. Later on the number of conductors was increased to three to meet the three-wire system then brought out. Hard rubber plugs were substituted for the wooden ones and circular copper for the semi-circular. The conductors were coupled together by means of flexible wire joints soldered to the ends, and the iron pipe was connected by a coupling box which was filled with a bituminous compound. Branches or services were taken off the mains by means of special Y or T boxes. This system was considered at that time very flexible, but it had the same disadvantage as the troughing in that the compound would run out or shrink, allowing moisture to enter, thereby causing a short circuit between the conductors, and it was still impossible to change the size of the conductors or increase the system without digging up the earth. This system was practically only the substitution of iron for wood. It was found that the life if iron pipe was limited to approximately fifteen years. The majority of companies throughout the country have removed this tubing and substituted the drawing-in system.

The next advance was the improvement in wires and cables. These were double or triple braided and compounded, giving greater insulation. This improvement in cables brought out the cast iron system, sometimes known as the Johnston system, which was simply the substitution of iron for wood troughing with the addition of partitions, making a multiple duct instead of a single duct conduit. This made it possible to increase the size and number of wires and gave a greater flexibility to the system, but it had several disadvantages; the life was comparatively short, being about fifteen years when not inclosed in concrete, and it made necessary a greater dielectric for the wires due to the possibility of grounding, also the possibility of abrasion to the cables became greater in this drawing-in system than in either of the solid systems previously mentioned.

Then came the wrought iron pipe, and improvements in cables, the lead covered type of the latter coming into general use. The iron pipe was enclosed in concrete thereby lengthening its life to a certain extent. The advantage was a complete drawing-in system; one by which the cables could be drawn in or out, and repairs made without digging up the pavement or earth. The disadvantages were:

(1) That the iron pipe was not an insulator.

(2) That the cables were liable to injury by abrasion in pulling in or out.

(3) That water or moisture caused the oxidation of the iron, thereby shortening its life.

(4) It required a better class of labor in bending and cutting threads on the pipe, and

(5) The price of pipe was high compared with wood.

Clay Conduits

These disadvantages brought out the clay conduits, which consist of two types, single or multiple ducts, with either square or round bore. This class of conduit is formed and vitrified, and then glazed by the salt process. The single duct type is made in 18-inch lengths, and the multiple duct type in 36-inch lengths. This material weighs about eight pounds per duct foot for the three and one-half-inch size. The cost of this conduit was far cheaper than that of iron pipe and gave the same general advantage, of a complete drawing-in system. Being more liable to injury in handling it required the education of the employes to realize that more care should be used to prevent breakage.

Advantages.

(1) This class of conduit is, perhaps, today, the lowest in price, f. o. b. factory, of any of the classes which are mentioned.

(2) When properly vitrified and glazed and free from iron, burrs, holes, etc., it is a high insulating material.

(3) It has the advantage of long life; in fact its life is indefinite.

Disadvantages.

(1) If not properly vitrified, glazed, etc., or if it contains iron to any extent, the insulation is lowered. If not properly glazed it will absorb moisture and as the weight per foot is high compared with other classes of conduit, the amount of moisture absorbed is higher per foot.

*Extracts from a paper given before the Railway Signal Association.

(2) Short lengths increase the number of joints over other classes and as the ends are squared a gap is left every 18 inches or 36 inches which must be closed with other material. This method of construction naturally removes the advantage of high insulation claimed for this material.

(3) Multiple duct, in addition to the above disadvantages, allows communication between ducts at the joints every 36 inches, thereby decreasing the safety factor of the cables. The single duct, although costing more to lay than the multiple, provides a greater safety factor.

(4) Owing to the weight of the conduit the freight per duct foot is higher than other classes.

(5) The loss in breakage has to be considered, as generally a break causes a total loss of the length, which, in a four-duct conduit means twelve feet. It is false economy to try to trim up the conduit, as the labor is generally more than the value of the material.

(6) The cartage and handling charges are comparatively high owing to its weight.

(7) A better and higher paid class of labor is necessary for installing clay conduits than for other classes.

(8) A large percentage of the conduit warps in vitrifying, and owing to its low selling price it cannot be furnished true to square ends, straightness, lack of blow holes, or burrs, and with thorough glazing.

(9) The possibility of abrasion to cables, either at the joints or by sharp projections inside, gives clay conduit no advantage over iron pipe.

(10) Although some manufacturers furnish bends they are not generally used in subway construction, it being considered advisable to install short radii curves or angles by means of manholes or hand holes, rather than run the risk of abrasion to the cables in pulling them under such conditions. The use of manholes naturally increases the cost of construction.

While this class of conduit is quite an improvement over those mentioned before, it required an advance in cable construction, and we find an improvement came in higher dielectric strength, in improvement in rubber compounds, in introduction of paper and cambric dielectrics, as well as in the use of other metals in the lead armor.

Fibre Conduit.

The next step was the use of wood pulp in conduit manufacture. The first type, perhaps, was that of the pressed wood pulp formed cylindrically and treated with a bituminous compound. This process was abandoned by the originators, owing to the liability of disintegration when placed underground. Later wood pulp wrapped in a minutely thin film upon a forming mandrel, under pressure, was formed cylindrically and after drying was indurated with a bituminous compound. Joints of the screw, sleeve and mortice and tenon type were cut on the ends in order to connect the lengths. Another type is that made by winding paper on a mandrel, and indurating during the process of manufacture.

The latest of this class is the return to the pressed type with a bell and spigot joint.

Advantages.

(1.) The conduit is of light weight, varying from 1.2 lbs. per foot to 3.5 lbs. per foot for the 3 inch size, according to the thickness of wall and type of joint. The light weight naturally reduces the freight, cartage and handling charges.

(2.) This material has high insulating qualities, but no higher, perhaps, than the virtrified clay in itself.

(3.) It makes a continuous duct without the objectionable open joints of wood and clay conduits.

(4.) It can be made up in bends and other fittings to meet the requiremnts, and thereby reduce the number of manholes or hand holes of other systems.

(5.) If broken it can be re-cut, thereby reducing the breakage charges to a minimum.

(6.) It requires a less expensive class of labor than other classes of conduits, but requires the education of the men to the fact that the material is light and easily broken.

(7.) It can be installed at a total cost of construction as low or lower than other materials.

(8.) It will not injure the cables by abrasion.

(9.) It better protects the cables from stray currents.

(10) It eliminates hysteresis losses when used in alternating current installations.

Disadvantages.

(1) Being a new class of material and liable to injury in handling, as well as possibility of injury by picks, etc., more care must be used than in any of the other classes.

(2.) Liable to unwind or disintegrate if not properly made. More easily affected by heat and climatic conditions than types previously mentioned.

(3.) It is affected to a certain extent by oils and is liable to destruction by fire from short circuits, although it is claimed that the combustion stops when short circuit ceases.

(4.) This material has less mechanical strength than any other class.

(5.) The life of the material is in question. It has been in use for 15 or 18 years, and as a guess it might last 50 or 100 years.

Concrete Ducts.

This class consists of two types. The first brought out was the duct formed and covered at the factory with sheet iron, which cover was later abandoned on account of its short life and the difficulty encountered in cutting the material on the work into short lengths. Later came the manufacture of this duct in the trench by the contracting company, and after this came the monolithic types formed in the trench, using covers of concrete for the top and divisions, or built by means of rubber or paper tubing filled with water or air to act as the form while the concrete set. When the concrete had set these forms were removed, leaving a complete monolithic structure.

Advantages.

(1.) It is claimed that the installation of this class reduces the cost of construction and gives a continuous duct without joints, and a flexibility not obtainable in the other classes of ducts.

(2.) The bore of the ducts is smoother, reducing the liability of abrasion to the cables.

(3.) The cutting down of freight and cartage costs to a considerable extent.

(4.) Practically indefinite life.

Disadvantages.

(1.) A higher cost of construction for the reason that a grout mixture has to be used, thereby making a more expensive composition than a mixture of concrete.

(2.) Great care must be used to get a smooth bore and a construction which is not porous.

(3.) Some engineers claim that a chemical action takes place between the concrete and the lead cable, but my experience is that the action is so slight as not to be worthy of consideration.

This class of conduit has not been generaliy accepted by the larger companies and it is reasonable to assume that it has proved to have no special advantage over other classes. The monolithic type, where tubes were used, gave a better construction than that made by wooden forms for slides, or a moulded cement top. All subways of this class give more or less trouble, caused by the grout running through the joints, thereby obstructing the ducts.

Suggestions for a Satisfactory Conduit.

A history of the various classes and types of conduits does not bring forth the recommendation of any one particular class of conduit as the most suitable for use as a substitute for wood trunking. It, therefore, will be necessary to add to the history of conduit construction by suggesting a conduit or combination of conduits that will meet the requirements of railroad work.

It will further be necessary to improve the wire and cable situation, for the reason that the two materials necessarily advance together.

The manufacturers understand that this is a new field for these materials and they would, without doubt, be glad to work with the signal engineers in developing a satisfactory system.

A description of a conduit system for railway signal work would, perhaps, bring out the necessities, and suggest possible improvements, both in the cable and conduit situations. The chief requirements of such a system seem to be as follows:

(1.) The best possible protection against interruptions.

(2.) Accessibility and flexibility.

(3.) The reduction of maintenance charges to a minimum.

(4.) The most approved methods of construction at the present time.

(5.) The lowest cost consistent with the above ideas.

A system meeting these requirements would take care of permanent installations both for direct and alternating currents. It is, of course, not to be considered for temporary work and it is offered to those who consider other factors of greater importance than the first cost of installation.

System.

In order to take care of all conditions, the system is divided into three sections—

(1.) The main subway.

(2.) The primary distributing system.

(3.) The secondary distributing system.

Main Subway.

For the main subway an excavation should be made which will allow the top of the subway to be about two feet below the surface in order to get, if possible, below the frost line, and to prevent injury and vibration. This trench should be so graded as to allow the drainage from manhole to manhole to be in one direction, rather than arched and drained in both directions.

The subway should be laid, if possible, outside of the tracks in order to lower the cost of construction, protect employes from injury and to make the system more accessible, allowing work to be done without interference from passing trains.

After the trench is dug side boards of wood (afterward removed) are placed in the trench, the proper width being allowed. The object of these boards is to prevent the waste of concrete. The next operation is the laying of the concrete base. This should have a thickness of from 1½ inches up, according to the number of ducts to be installed. A concrete mixture of 1, 3, 5 would be, perhaps, the best for concrete.

Conduits.

In order to reduce the laying cost to a minimum, single ducts of approximately five feet are recommended. A continuous duct should be formed of the same material from manhole to manhole. The ducts should have a type of joint which will allow sufficient flexibility to work around curves or bends. Bends should be made of the same material as the straight lenghts and all joints should be sufficiently tight to prevent cement or water working in.

The duct material should absorb a very small amount of moisture, should be a good insulator in itself and as great an insulator at the joints. It should prevent stray currents entering the ducts and should eliminate hysteresis losses when used for alternating current. It should be a material that will not cause abrasion to the wires or cables and one that is easily cut into when necessity requires. It should also be light in weight to reduce freight and handling charges.

The ducts should be so laid as to divide into groups cables of three general classes of voltage. Those below 100 volts, those between 100 and 600, and those over 600 volts.

In laying the conduit, wooden separators, ¾ of an inch wide, and of a sufficient length according to the number of ducts to be installed, should be placed between ducts; these separators, of course, being removed after the last tier of conduit is laid.

After laying the first tier of conduit the concrete should be filled in, carefully tamped, and raised to allow the necessary separation horizontally between that tier and the next. A subway may be built in a number of tiers by this method, allowing the concrete to set on each tier before the next is put in. On completion of the laying, the top concrete should be increased in thickness to about two inches in order to protect from mechanical injury. In railway work it would not be necessary to carry around the conduit the usual heavy envelope of concrete, such as used in city streets.

The main subway should be in sections not over 300 feet in length ending in manholes, but before entering same the different groups should be spread out in order to separate the cables at the entrance to the manholes.

Manholes.

Manholes of concrete or brick, with 8 to 12 inch walls, depending upon size of the subway, should be installed at the end of each section. These manholes should be of sufficient size to allow ease in jointing cables, as well as to furnish a protection to employes from passing trains. Each manhole should be connected with a ditch or drain pipe three inches to four inches in size, and where necessary, with traps of the Peny type to prevent return. The manholes should be either of the single type, with divisions and partitions to separate the classes of cables and individual cables of each class, or double, the wall of one side forming the wall of the other. It is considered absolutely necessary to keep the various classes of cables distinct and separate wherever possible, and if it is not done in the manhole the scheme of separation in the conduit duct section is not carried out. Manhole frames and heads should be of cast iron, light in weight for easy handling, and provided with lock bars to prevent accessibility to outsiders. Their weight, as compared with electric light frames, should be greatly reduced. The frame openings should be square or round, not rectangular, in order to prevent the cover from falling into the manhole. Cable racks or cable partitions should be provided in the manhole and cables carefully racked and tagged, showing by their tag numbers, not only the cable number, but by a combination of numbers the voltage of that cable. For instance, cables carrying about 600 volts would have their first number 6, as 601; cables carrying voltages from 100 to 600, would start with the first number as 101; cables under 100 voltage would carry their letter or number as 01. Tags should be of aluminum or copper, and fastened to cables either by solder or copper wire.

Primary Distributing System.

The primary distributing system is constructed in connection with the main subway, and for extension to the main line, the same general plan should be used, cutting down to two divisions and using hand holes instead of manholes. Conduit bends of fair radii should be used to reduce the number of hand holes as much as possible, but not to the extent of more than two 90 degree bends when there is a curve in the system. The object of this is, of course, to avoid blocking the cables in pulling them in or out. This primary distributing system branches from manholes of the main subway, and should end above ground, if possible, in terminal junction boxes or signal towers. These terminal boxes would have to be developed and should probably be made of metal, waterproof and double-doored. They should be furnished with terminal plates inside of sufficient size to take care of the number of cables and should have partitions or barriers to separate the various voltages. These boxes should have protection against sweating by means of an opening at the surface, which should be so constructed as to prevent any water entering the box. Such boxes are in use at the present time on the electric light systems, and as there are a number of types, one could be selected, which, with slight changes, would meet the conditions in railway signal work.

We have now provided for:

(1.) A complete pulling-in system.

(2.) One installed underground with openings accessible whereby cables may be changed or added to.

(3.) All the mechanical protection necessary.

(4.) Reduction of maintenance charges.

(5.) A system installed under most approved methods of construction at the present time, and

(6.) The cost of construction will be lower by approximately 20 per cent than those subways built by electric light and telephone companies at the present time owing to the reduction of concrete, and the use of a lining conduit of light weight and of sufficient thickness for this purpose.

Cables.

For the main cables single or multiple rubber insulated lead armored cables are used. It will probably be found that multiple cables, where circuits of the same voltage are used, will be cheaper in first cost as well as cost of installation than single conductors. Spare wires run in these multiple cables will allow flexibility, with the possibility of increasing the system, if necessary. Such cables are now in use and will require no improvement, the only suggestion being that the insulation be reduced in thickness to meet the lower voltages used in signal work.

In order to make jointing as simple as possible, getting rid of the blow torches and the soldered connector, the mechanical type of sleeve joint should be used. By its use corrosion, so often caused by the use of soldering compounds, and broken wires caused by poor workmanship, will be gotten rid of. These mechanical joints allow of quick connection and disconnection; can be used over again if necessary, and can be made in such form that one joint will take care of a number of different sizes of wire. The conductivity of these sleeves or mechanical joints is as good and really better than obtained by soldering, when the number of joints whose conductivity is reduced by poor soldering are considered. The joints of the lead armor can be wiped either in the usual manner or by the use of one of the special wiping tools now on the market; this tool does not require as skilled labor as those made by hand wiping.

Secondary Distributing System.

By secondary distributing system is meant that part which is separate and distinct from the main subway and covers track circuits and boot-leg connections. Starting with the battery chutes or wells, a single duct of sufficient size (from 1½ inches to 3 inches inside diameter) is laid and enclosed in an envelope of concrete to the signal or relay box as the case may be, and to a distributing box as previously described. From this point two suggestions for boot-leg connections are made.

If track connections are not numerous or complicated, single ducts can be laid underground from the distributing box to the rail. In order to prevent mechanical injury, it is advisable, at the rail, to use an iron bend connected to the conduit by means of a reducer, and the iron bend should be supported by a piece of strap iron fastened to two ties. If a bend of the duct material is used at the rail it should end in a post of concrete with an iron cap.

Another boot-leg connection can be made by using short lengths of flexible wire iron armored cable which can be run from the distributing box to the rail. This armored cable, although not new, will have to be developed to meet railroad conditions. It will be found of great use, not only to take care of conditions above described, but to be used in combination with the regular cable. For example, when running up poles to connect underground cables with overhead wires and in bridge or ditch work. It can be laid in the earth without any protection and should be brought to the rail through a short piece of iron pipe, held in place as previously described. Two connections could be made to the rail by joining two short pieces of iron wire as now used, to the main cable, by means of a mechanical joint. To protect the joints an elbow of the split condulet type should be used, the joint itself being insulated with one of the splicing compound tapes now on the market. The advantage in this joint is that it may be connected or disconnected when occasion requires without the use of solder and the rail connection may be removed without cutting into the main cable.

Conclusion.

The above description of the subway and cable combinations cover as many points as is possible but it is to be understood that the principal idea is to give a general scheme rather than one in detail. Many combinations can be used and I believe that they will cover any and all possible needs wherever it is decided to substitute a pulling-in conduit system in place of wood trunking.

The Maintenance of Way Department

RELATION OF TRACK FASTENINGS TO CREOSOTED TIES.*

By Mr. Herman von Schrenk, Supervisor Timber Preservation, C., R. I. & P. R. R.

We have been going along increasing our locomotive power, increasing the weight of our freight cars, and increasing the capacity or tonnage that we are able to haul over our tracks, but we have practically today a type of track structure which differs in but few points from that which has been in use for a great many years. As a result it has come to be universally felt to be one of the leading problems that the railway world is facing at the present time—that of so modifying our track structure as to increase its capacity to haul the tonnage which is thrown upon it, and at the same time increase its longevity and its security.

One of the chief reasons why this problem has come to be of such grave importance is because of the rapid depletion of our high-grade timber, such as we have been using for tie purposes. White oak, our chief standby for that purpose, has come to be considered of such great value for other purposes that its use for ties makes it almost an economic crime on the part of the railroads. And in saying this I want to emphasize the importance of this matter with all the strength that I am capable of.

Beginning with the fact that we can no longer use white oak for ties, we naturally have to turn to some other material—a material which is not equal, in its tensile strength, lasting power, etc., to white oak, and therefore we must necessarily turn to preservation—chemical preservation—of these woods, in order to make them last.

Then immediately comes up the question, "How are we going to preserve the ties?" And the question is frequently propounded to me, "How long will a creosoted tie last?" These questions are asked by the track man, as well as the executive officer.

The answer to that is that you can make a tie last almost as long as you want to, from a chemical standpoint—that is, against decay—but we have at the same time an added difficulty on account of the mechanical abrasion to which the ties are subjected.

There is a difference between the mechanical problem that we have to meet in America today, and in the United

*A paper given before the St. Louis Railway Club.

States particularly, as contrasted with the practice which has obtained for a great many years on many of the European railroads where they have had to fight this problem a great deal longer than we have.

I propose very briefly to discuss some of the mechanical problems as we have them, and to illustrate how some of the European roads have met them, and, if possible, to draw some idea from the railroad practice of today of what the problem will develop into in the future.

At the present time there are four different ideas as to the proper track fastening, prevalent in Europe. The first system was illustrated by the English chair, in which there is no connection between the rail and the tie, the rail being held by the chair and a wooden key. The second system was exemplified by the chair tie plate used by the Austrian State Railways. This is a large, flat plate, fastened to the tie by means of three screw spikes. The rail is fastened to the tie plate by means of two bolts and a system of clips. Both the English chair and the Austrian chair tie plate represent the idea that it is not desirable to have the fastening hold both the rail and the tie plate at the same time. In both these cases the fastening of the tie plate is entirely independent of the fastening of the rail. The third system is exemplified by the type of tie plate used on most of the German railways, also in Sweden, Denmark, Italy, etc., this being, with some modification, the type of tie plate used in this country, only in the majority of cases the tie plates are flat bottomed and the fastening consists of screw spikes, which pass through the tie plate and impinge on the base of the rail. The fourth type is that in use on the French Eastern Railway. The engineers of this company maintain that it is impossible to obtain a rigid fastening of a steel rail, a steel tie plate and a wooden tie. In consequence they use what we would call a wooden "shim." This wooden shim is exactly the width of the base of the rail, and as long as the tie is wide and about one-eighth inch thick. It is placed under the rail and two or more screw spikes hold the rail firmly against the tie. This shim acts as a sort of cushion between the base of the rail and the tie, and whenever any of them wear out a slight turn of the screw spikes allows a new one to be inserted. It is stated that even with the heavy motive power used on this road at the present time these shims give excellent service, and from the writer's own observation during the latter part of last year he is able to confirm the claim made that creosoted beech ties, after a service of thirty years or more, show hardly any signs of mechanical abrasion under the rail.

It is very desirable for American railway engineers to consider the relative value of these ideas in connection with American track. In the American practice there is a very large renewal of ties in this country, owing to mechanical wear due both to rail wear and spike killing.

Thus very briefly I have tried to outline some of the problems that we have today; I am sure that within the next few years the progress that we shall make will be perfectly surprising. How many miles of road we will find which will have adopted some of the features I have presented tonight I cannot say, nor whether these particular devices will be adopted as they now stand. We have to try out the various claims, and it all depends upon the type of country in which they are used, and one fact I must not forget to state: we must not forget that the best results in matters of this kind are only to be obtained by using chemical preservatives when the other conditions of track warrant our doing so. In other words, if we have a track which is sandy, or dirt, or cinder track, even, in which the motion is very great, it will hardly pay to anchor the tie down hard with these same fastenings that I have shown you. Improved fastenings are to be considered more in connection with the stone-ballasted track, where the motion is reduced to a minimum.

When fastenings of the character that I have described you are employed, there is no reason why a tie should not last 25 or 30 years, the same as they make them last in France.

Last summer a French engineer said to me, when I went over there to look at his track for the fifth or sixth time: "Oh, there is no use of your coming any more; we have no tie problem." He said: "We pump them full of creosote oil and they last almost indefinitely." Further, they are not bothered with any labor proposition, because of the smaller number of ties that they have to renew.

SCREW SPIKES.

Editor Engineering:

For several years we have been using screw spikes on our stone-ballasted lines in connection with creosoted ties. We find they are entirely satisfactory, and advocate their use for lines of this character.

The life of ties has been materially increased through the treatment by creosote. When used in the ordinary way, i. e., with ordinary spikes, the ties will endure about fifteen years, while the same ties will doubtless endure for twenty-two to twenty-five years if screw spikes are used.

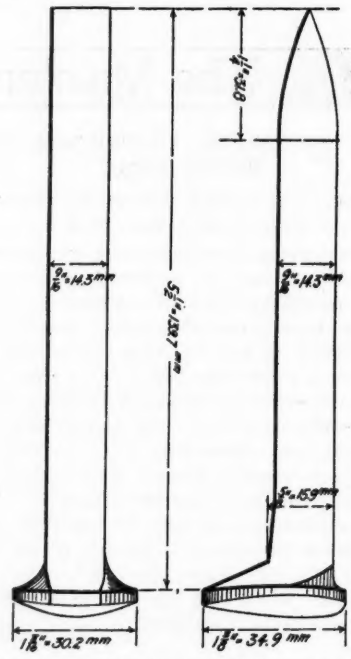
As to the effect of heaving if screw spikes are used, it should be noted that the rail carries the ties with it, and while the screw spikes may not be withdrawn from the ties if carried with them would leave a hollow space under the ties adjacent to the point where the heaving occurs.

Relative to the use of wooden tie plugs to receive the screw spikes: This seems to be somewhat of an open question. We have not considered it worth serious consideration. The creosoted ties used by this company are bored for screw spikes in advance of being treated, and should it be found necessary to introduce wooden plugs in the event of the screw spikes having lost their hold, believe the introduction of the plugs could be made without great difficulty.

(Signed) Edw. Gagel, Chief Engr.
N. Y. N. H. & H. R. R.

Editor Engineering:

Replying to yours of the 18th ult., will say that we do not

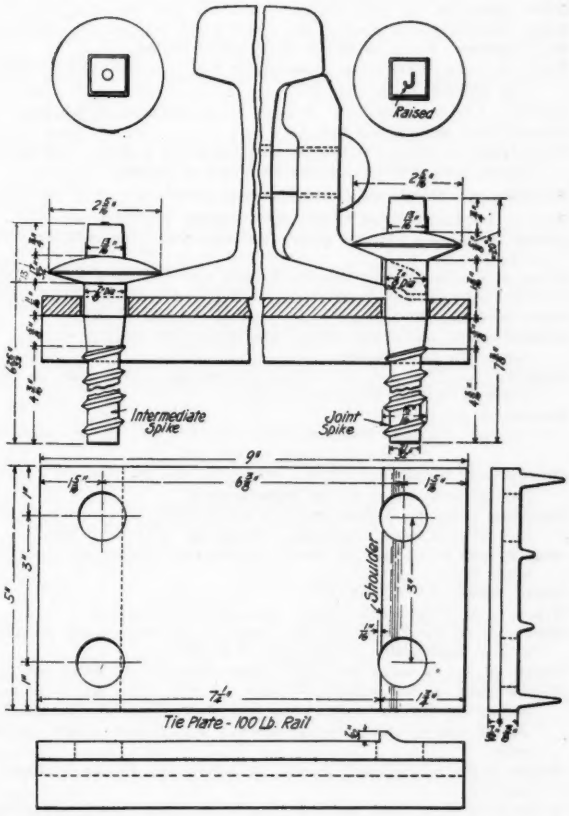


Standard Drive Spike, National Railways of Mexico.

use screw spikes. Our standard drive spike is $\frac{9}{16}$" x 5½". While superintendent of construction of The Royal Trans-African Railway, 1886-90, I used the screw spikes on ballasted track, and found them to be very efficient.

The Belgian creosoted ties were bored to receive the screw spikes, and when inserting them the use of a hammer was positively prohibited. With the improved tie-boring and spike-screwing tools, I believe that the screw spike has many advantages over the common nail spike. Its holding power is about four times greater and does less damage to the wood fiber of soft wood and treated ties. With many of our hard wood ties, I do not think it would be economy to use the screw spikes.

(Signed) James M. Reid, Chief Engr.
National Railways of Mexico.



Standard Screw Spike and Tie Plate, N. Y., N. H. & H. R. R.

The Santa Fe has planned to construct a new stock yards track at Deerfield, Kan., and new tracks at Moline, Kan.

The Oregon-Washington R. R. & Navigation Co. will build a new machine shop on Delaware avenue in Seattle, to cost $30,000.

Mueller & Taylor, Vancouver, B. C., have been awarded the contract for erecting 13 concrete bridges between westminster Junction and Mission for the Canadian Pacific. The work consists of 8 culverts, one arch and two 30 ft. and two 40 ft. span structures. The bridges are all to be double track.

The Missouri, Kansas & Texas has started construction on sheds for repairing and overhauling cars at the following points in Texas: Dallas, Denison, Ft. Worth, Greenville, Ray and Smithville.

TRACK WORK.

It is useless to put creosoted ties in a track without good substantial tie plates and new spikes on every tie. Tie plates of insufficient thickness will bend and will crush the wood, leaving a basin for the retention of moisture. If tie plates are not used, creosoted ties will be destroyed by rail cutting, long before the tie decays.

If good surface is not maintained on a track the continual pounding of the wheels will batter and cause broken rails, and the shock will hammer and soon destroy the ties. If short kinks are allowed in the line, the lurching of the train will soon cause low spots and rough track, as well as bad gage.

It is a poor and expensive policy to combine section gangs and concentrate them on one section. Time is lost in going to another section, and the work done by the visiting section men is liable to be below standard in quantity and quality. It is only natural for a competent hard working foreman to resent being compelled to neglect his section and assist another foreman, one who is possibly negligent or incompetent. This policy may bring the sections of a competent and incompetent foreman to the same degree of excellence, but the better foreman's work will not produce a showing, and this reduces his incentive for work.

Track walking and watching is now neglected on many American railways with a resultant decrease in safety and good maintenance. In England the track is walked over every day in order that it may be known to be safe for traffic from actual inspection, and the track walkers are all trained section hands.

Rough spots would often be detected by a track walker and could be remedied immediately. A foreman should never be expected to work as one of the laborers; his time can profitably be entirely taken up by supervision, and careful inspection of track and roadway in the vicinity of the work being performed.

The best way to make tie renewals, is to put in all ties early in the spring. Spike the tie as soon as put in the track nipping up the tie with a bar, being sure that the tie finally is held snugly to the rail. Tamp the ends of all new ties and only about 16 inches inside the rail as the part of the tie close to the rail receives the maximum load. Tamping the center of ties causes center bound track.

It should be the personal duty of the Roadmaster to examine and see that all work is properly done. It is advisable, if possible, to make roadmasters of practical track men of wide experience, both in construction and maintenance.

It is bad practice for a roadmaster to tell a foreman he must put in 12 or 15 ties each day per man. Many times this will cause a foreman to take out a number of adjoining ties, even though some of them may be perfectly sound, in order to reduce the amount of digging and increase the number of ties put in. I have personally seen 60 new ties put in four rail lengths and treated ties less than 7 years old removed in this manner.

Camp cars are put in at each station and a low class of foreign labor is being used on many railways in the country. The best American and foreign trained track labor has gone into other fields of employment. On account of heavier rolling stock the difficulty of keeping good track has been increased, while the efficiency of the available labor has decreased, making the section foreman's position more difficult than ever before.

Foreman, C. & E. I.

Even boldness and assurance are better than the mildness which smacks of indifference. A man once hung a "Boy Wanted" sign outside his door; in a few minutes a freckled youngster with a square chin brought in the sign, and calmly laid it on the man's desk. "Hey, what are you doing with that sign," demanded the man. "Yer don't need it any longer," calmly replied the youth. "I'm yer boy!" And he was.

Glossary of Track Terms

K. L. Van Auken.

The words in this glossary have been collected largelyfrom personal experience and some of them are undoubtedly local terms, or words used on certain railways or in certain sections of the country. It may be possible that some of the terms have a different meaning as used by some of our readers. It should also be borne in mind that all the words refer specifically to track, and may have meanings totally different in other trades or vocations. Furthermore, a list such as this is susceptible of constant additions and is not claimed to be complete. Additions which will make the collection more complete will be welcomed, and may be pub-lished at a later date.

Adjustable switch rod, n.—A head rod carrying a device for varying the distance between the point rails of a switch.

Advance block signal, n.—A fixed signal used in connection with home block signal to divide the block in advance.

Air-line, n.—A main line of the highest class as to gradient roadbed and track.

Alinement, n.—The horizontal location of a railroad with reference to curves and tangents.

Angle bar, n.—
See (1) Compromise angle bar.
(2) Continuous angle bar.
(3) L. & S. angle bar.
(4) Long-and-short angle bar.
(5) Long punch angle bar.
(6) Offset angle bar.
(7) Short punch angle bar.
(8) Step angle bar.

Apron, n.—A short wide piece of sheet iron placed with the ends on the floors between two ballast cars to prevent ballast from falling on the track when unloading with a dirt plow.

Armstrong, n.—A speeder. A hand car on which the operator is seated as he propels the car.

Assisting grade, n.—The inclination given to tracks of a yard to facilitate the movement of cars.

Automatic switch stand, n.—A switch stand which will throw automatically and allow a trailing train movement without damage, although the switch is lined up for the wrong track.

Backing, n.—(1) Rough stones used on the back of a masonry wall; (2) Gravel or filling behind a wall or abutment.

Ball, n.—"Ball of rail." The top heavy portion of the rail with which the wheels come in direct contact.

Ballast, v. t.—To raise a track, tamping and filling with ballast.

Ballast, n.—Selected material placed on the roadbed for the purpose of holding the track in line and surface.

Ballast, n.—
See (1) Broken stone.
(2) Burnt clay.
(3) Chats.
(4) Chert.
(5) Cinders.
(6) Disintegrated granite.
(7) Gravel.
(8) Slag.

Ballast plow, n.—(1) A plow for unloading ballast from cars; (2) A plow for spreading ballast which has been dumped in the center of a track.

Ballast stake, n.—An engineer's stake set so that the top is at the height the rail is to be when the track is surfaced.

Ball'er, v. t.—A command to the rail gang, holding a rail, to turn the ball toward their bodies.

Ball-worn, adj.—"Ball worn rail." A rail on which the ball has been badly worn.

Base, n.—"Base of rail." The flat, bottom part of a rail which is in direct contact with the ties.

Battered, adj.—"Battered rail." A rail the end of which has been pounded and flattened by passing wheels.

Belt, n.—A line built around a city, for the local distribution or transportation of freight.

Bend, v. t.—"Bend the rails." To throw a switch.

Bent, n.—The piles and cap, or trestle work, which supports bridge stringers.

Berme, n.—An approximately horizontal surface between the top or toe of a slope and a boundary line, ditch, or other excavation, for the protection of the slope.

Blade, n.—That part of a signal arm which, by its form and positions, gives the day signal indications.

Blade, v. t.—"To blade-in ballast." To shove stone ballast under the ties with shovels.

Block, n.—A length of track of defined limits, the use of which by trains is controlled by block signals.

Block, n.—
See (1) Expansion block.
(2) Filler block.
(3) Heel block.
(4) Nipping block.
(3) Spot board blocks.

Block signal, n.—A fixed signal controlling the use of a block.

Block station, n.—A place from which block signals are operated.

Block system, n.—A series of consecutive blocks.

Blow, v. i.—A hobo term meaning to quit the job, and to leave that section of the country.

Blow, v. i.—To "blow-in." A hobo term meaning to arrive.

Board, n.—A semaphore signal.

Body track, n.—Each of the parallel tracks of a yard or group of tracks upon which cars are switched or stored.

Bohunks, n.—Austrians, Polacks, or Bohemians.

Boil, v. t.—To "boil up." To wash clothes, blankets, etc.

Bolted frog, n.—A frog in which the point and wing rails are held together by bolts.

Bond, v. t.—To connect two track rails together by a wire at the joint so that an electric current may pass through the track.

Bond wires, n.—The short wires used in bonding a joint.

Bonded joint, n.—A rail joint past which an electric current is carried by bond wires.

Boot-leg, n.—The part of a line of trunking which dips to pass under a rail or other obstruction.

Borrow, v. t.—
(1) To take material from a borrow pit; (2) **n.**—Material removed from a borrow pit.

Borrow pit, n.—An excavation made for the purpose of obtaining material for a fill or embankment.

Bounding post, n.—A post marking the division line between right of way and other property. Same as "boundary post."

Branch line, n.—A line of lesser importance, leading off from the main line.

Brass collar, n.—An official.

Break, v. t.—"To break track." See cut "to cut track."

Break up, v. t.—"To break up a train." To switch out or make a new distribution of the cars in a train.

Break up, n.—A track or tracks where trains are broken up.

Bridge joint, n.—A suspended joint. A rail joint which is supported by one tie under each end of the joint fastenings, but which has no tie directly beneath the meeting joint of the rails.

Bridge sign, n.—A small board on which the bridge number is painted.

Bridle box, n.—A box for carrying bridle rods (taken off behind track machines) ahead of the track machine. The box is placed in the tie trams.

Bridle man, n.—A man who places bridle rods on the rails ahead of a track laying machine.

Bridle rod, n.—A rod with the end turned up to hook over the outside of the rail base, and hold unspiked rails to gage. Also used to prevent spiked rails from spreading.

Broken joints, n.—Rail joints which are not opposite each other in a track.

Broken stone, n.—Stone broken by artificial means into small fragments of specified sizes, for ballast.

Broomed rail, n.—A rail the ball of which has been crushed and flattened in spots.

Bubble man, n.—The man who carries the level when surfacing track.

Buck, v. t.—(1) To move a string of rails by hitting the end of the string with another rail used as a hammer. The latter rail is launched endways by a number of men, and delivers a sharp horizontal blow; (2) To set the end of a rail, a switch point or a frog, against the end of another rail already set up.

Buck, v. t.—"Bucking ties." Carrying out and distributing ties ahead of a track laying machine.

Buck, v. t.—"To buck up expansion." To decrease the expansion spaces in a track, by bucking up the rails.

Bulk head, n.—A wall of wooden timbers behind which dirt is confined or retained.

Bull dozer, n.—A large plow attached to the side of a car; used for leveling off piles of dirt at the side of a track.

Bum, v. t.—(1) To ride over the country without paying fare. (2) "To bum a lunch." To beg a lunch.

Bump, v. t.—To "bump a man." To displace a man on any job.

Bumping post, n.—A strong post solidly anchored and braced at the end of a stub track to stop cars or engines from leaving the track.

Burnt clay, n.—A clay or gumbo which has been burned into material for ballast.

Butcher, n.—"Bridge butcher." A bridge workman.

Butcher, n.—"Track butcher." A track workman.

Car, n.—
See (1) Ballast Car. .....
(2) Dump car.
(3) Trimmed car.

Cant, v. t.—"Canted rail." A track rail which is tipped, so that it does not set perpendicular.

Canary, n.—A section-foreman.

Cast, v. t.—"To cast dirt." To throw dirt several feet with shovels.

Catch siding, n.—An upgrade used in mountainous countries to side track runaway trains or cars.

Cattle guard, n.—A device placed between the rails and used in connection with wing fences to prevent cattle from passing inside the right-of-way.

Center frog, n.—The middle frog in a three throw switch.

Center line, n.—A line marking the center of an excavation, embankment or of a track.

Center plow, n.—A dirt plow which plows the dirt or ballast off of a train, delivering it on both sides of the track.

Center punch, n.—A pointed tool, used to mark the center point where a bolt hole is to be drilled.

Center stakes, n.—Stakes marking the center line.

Channel switch, n.—A split switch, to the points of which guard rail stiffeners are attached.

Chats, n.—Tailings from mills in which zinc and lead ores are separated from the rocks in which they occur.

Checks, n.—Small cracks in the wood of a tie due to seasoning.

Chert, n.—An impure flint or hornstone, occurring in beds, used for ballast.

Cinders, n.—The residue from the coal used in locomotives or furnaces.

Cinder track, n.—(1) A track ballasted with cinders; (2) A track on which cinders are loaded into cars.

Clamp, n.—"Switch point clamp." A device for clamping safely the temporary switch point connection used in relaying track.

Clamp frog, n.—A frog in which the different parts are held together with clamps and keys.

Clamp gage, n.—A notched tool for holding rails to gage for the iron car while laying steel.

Classification yard, n.—A yard adjoining a separating yard, in which cars are classified or grouped in accordance with requirements, preliminary to forwarding in trains.

Clean break, n.—To break rail so that it shows smooth squarely broken end surfaces.

Clear, v. t.—To place beyond reach of moving trains. (Used in the infinitive form).

Clearance, n.—Distance beyond the extreme outside line of moving trains, to the nearest point on a building or other obstruction.

Clearance post, n.—A post set at point of clearance on converging tracks.

Close, v. t.—"To close-up track." To put in connections, or to make continuous a track which has been disconnected. See "connection."

Cluster or general yard, n.—An arrangement of yards in series for the separation, classification, assembling and storage of cars.

Compound curve, n.—A change of direction consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

Compromise angle bar, n.—Same as "step angle bar" or "offset angle bar." An angle bar designed to make a smooth joint of two rails of different size.

Compromise joint, n.—Same as "step joint." A joint between two rails of different sizes.

Connection, n.—To "make a connection"; to close up, or make continuous, a track which is disconnected.

Continuous angle bar, n.—(1) A combined angle bar and base plate. (2) An angle bar which has a flat base portion extending under the rail.

Continuous plate, n.—Used same as "gage plate." A tie plate reaching clear across a tie, or under two or more rails.

Corduroy track, n.—Track layed on brush or logs across a swamp or marsh.

Cotter, n.—See key. A pin which is placed in a hole provided for the purpose in a bolt, to prevent the nuts from turning off.

Creeping, inf.—"Creeping rails." Track rails which are moving longitudinally.

Crib, v. t.—To build a temporary track foundation, consisting of timbers placed systematically upon others, forming a substantial structure.

Crib, n.—A temporary track foundation built of timbers built up systematically one on the other, to form a substantial structure.

Cribbing, n.—Same as "crib."

Crossing frogs, n.—"Frogs placed where two tracks cross.

Crossover, n.—A double ended turnout connecting two tracks. (Camp.)

Crossover track, n.—A track connecting two adjacent tracks.

Cross-tie, n.—That transverse member of a railway track which supports the rails and by means of which they are retained in position.

Crotch frog, n.—A switch frog used where both leads are curved and the curves continue behind the frog.

Crowd, v. t.—"To crowd men." To hurry up or "drive" a gang of men.

Cull tie, n.—A second-class tie. A tie which has been culled out from first class ties.

Curve, n.—A change in direction by means of one or more radii.

Curve, n.—
See (1) Compound curve.
(2) Easement curve.
(3) Heavy curve.
(4) Reverse curve.
(5) Sharp curve.
(6) Simple curve.
(7) Spiral curve.
(8) Vertical curve.

Curve monument, n.—A permanent mark set at the point of a curve, on which information is given as to degree, elevation, etc.

Curve sign, n.—Same as "curve monument."

Cut, v. t.—"To cut in a connection." (1) To put in a switch. (2) To cut and place rails to form a track connection between the old and new rails, when relaying track.

Cut, v. t.—"To cut track." To disconnect any of the rails of a track.

Cut-off, n.—A track which shortens the original line.

Dead end, n.—The end of a stub track.

Dead head, v. i.—To ride on free transportation.

Dead head, n.—(1) An obstruction placed at the end of a stub track to prevent cars running off at the end. (2) A passenger riding on free transportation.

Dead man, n.—(1) A buried timber to which a guy rope or block and tackle is anchored, or against which a brace is placed; (2) A fraudulent name carried on a payroll for which there is no laborer in the crew.

Dead rail, n.—Any rail in a track which does not receive the direct bearing of wheels.

Dead track, n.—A disconnected piece of track, over which trains cannot be operated.

Detector bar, n.—A bar placed at a switch or derail alongside of and normally below the top of rail, operated in connection with a facing point lock, derailing device, or switch, or so that its operation, and consequently that of the lock, will be prevented by the presence of any of the wheels of the train.

Departure or forwarding yard, n.—A yard in which cars are assembled in trains for forwarding.

Dinky, n.—(1) A short local passenger train; (2) The stationary engine on the pioneer car of a track laying machine; (3) A narrow gage locomotive; (4) A small, old fashioned engine.

Dinky-skinner, n.—(1) The engineer who controls the live rollers and through them the speed of the ties and rails, in the trams of a track laying machine; (2) The engineer of a narrow gage locomotive.

Dirt track, n.—Same as "mud track." A track surfaced with dirt.

Disintegrated granite, n.—A natural deposit of granite formation, which, on removal from its bed by blasting or otherwise, breaks into particles of size suitable for ballast.

Distant block signal, n.—A fixed signal used in connection with a home block signal, or a home and advance block signal to regulate the approach thereto.

Distribution track, n.—(1) A track in a material yard from which different kinds of material are unloaded and piled; (2) A track in a freight yard where cars are stored ready for distribution to industry tracks, or for transfer to other roads.

Doty tie, n.—A tie affected by fungous disease.

Double slip switch, n.—A slip switch with two curved track connections affording two routes for passing from one track to the other.

Double-up, v. t.—To combine two or several track gangs.

Drag, v. i.—To quit work in order to obtain wages which are due, with the idea of returning to work after the money is procured.

Draw, v. t.—To "draw a rail in." To move a rail laterally in driving the spike home.

Dress, v. t.—To "dress up track." To fill in and smooth up the ballast between and at the ends of the ties, and to build shoulder.

Drift bolt, n.—(1) A bolt which is driven through two or more heavy timbers, to bind them together. (2) A bolt used for holding caps and stringers in place.

Drill track, n.—A track connecting with the ladder track and used for movements in yard switching.

Drive, v. t.—To "drive a spike home." To drive a spike far enough to make the head rest snugly against the base of the rail.

Drive, v. t.—"To drive expansion." To close or open up the expansion openings at rail joints to the desired distance.

Drop, v. t.—"To drop a tie." To skip a tie.

Dump, n.—A fill or embankment.

Dump, v. t.—(1) To unload dirt or ballast; (2) To unload a ballast car, a dump car, or a dump wagon; (3) To release the automatic device on a dump car or wagon, so that the dirt is unloaded.

Dump car, n.—Same as "dumpy" or "leary." A four wheeled flat bottom car used for moving track or other material by hand.

Dump wagon, n.—A wagon used in grading, having an automatic device for unloading or dumping material through the bottom.

Dumpy, n.—Same as "dump car," or "leary."

Dust, v. t.—"To dust a rail." To raise up and drop a rail repeatedly in order to remove sand, ice, or other loose material from its surface.

Dutchman, n.—(1) A piece of rail a few inches long used to fill an opening between the ends of track rails; (2) Any short piece of rail.

Easement curve, n.—Same as "spiral curve." A curve of regular varying radii connecting a tangent to a simple curve, or connecting two simple curves.

Eagle eye, n.—A locomotive engineer.

Elevation, n. (as applied to curves).—The amount which the outer rail is raised above the inner rail.

Elevation, n.—"Running in" elevation. Gradually raising one rail above the other, when approaching a curve.

Elevation, n.—"Running out" elevation. Gradually bringing the track back to level after emerging from a curve.

Embankment, n.—A fill. A bank of earth or other material constructed above the natural ground surface.

Emergency, n.—The emergency air brake.

Endo, v. t.—A command meaning to move a rail, or other heavy object endways.

Engine, n.—"Dummy engine." A small locomotive used in industrial plants or on construction work.

Excavation, n.—(1) The material taken from cuts, borrow pits, or foundation pits; (2) The space formed by removing material; (3) The cutting down of the natural ground surface.

Expansion, n.—The space for longitudinal movements at the rail joints in a track, necessary on account of change of length of rails with change of temperature.

Expansion block, n.—Same as "expansion plug." A piece of rail used to close a gap between the ends of two rails in a track. Its length may be from a fraction of an inch to several inches.

Expansion plug, n.—Same as "expansion block."

Extra gang, n.—A transient gang which is employed on other than regular section work; usually a large gang.

Eye, n.—The space between ties on the outside of the rail.

Facing point, n.—A switch or frog which points against the movement of trains.

Farmer, n.—A person with no experience in railroad work.

Fastenings, n.—"Track fastenings." Splices, bolts and spikes. "Auxiliary fastenings."—Nutlocks, tie-plates, rail braces, and anti-creeping devices.

Feeder, n.—A branch line.

Fiddle, n.—An instrument for marking the proper position on ties, for the edge of the base of rail.

Fiddle, v. t.—To put chalk marks across the upper face of a tie on the line side, using the "fiddle."

Fiddler, n.—The laborer who fiddles ties.

Fill, n.—Same as "embankment."

Filling, n.—Material used in making embankments.

Filler block, n.—A casting placed between the guard rail and main line rail. The thickness of the block is adjustable or is such that the guard rail will be in its proper lateral position when resting snugly against this block.

Finisher, n.—A man who levels off the grade behind the grading gang.

Finishing stakes, n.—Final stakes set for the completion of the work.

Fish plate, n.—A flat piece of iron with holes drilled in it used for making a joint between two rails. Distinguished from an angle bar by being perfectly flat, and resting against the web of the rail only.

Fixed signal, n.—A signal in which the arm or disc is stationary, and can give but one indication.

Flange, n.—Same as "base of a rail."

Flanger, n.—A machine provided with small plows for removing snow and ice from the gage side of rails.

Flanger sign, n.—A sign board and standard symbol, denoting an obstruction in the track ahead, to pass which the flanger plows must be raised,

Flange-way, n.—(1) The distance between a guard rail or crossing plank, and the main rail; (2) The distance between the wing of the frog and the running rail.

Flatten, v. t.—To "flatten a curve." To reduce the degree of curvature.

Foreman.—"Extra gang foreman." The man in charge of an extra gang of laborers.

Foreman, n.—"Section foreman." The foreman of a crew of men in charge and responsible for the maintenance of a section of track and right of way.

Freight yard, n.—A railroad yard where freight cars are stored and freight trains are made up.

Frog, n.—A frog is a union of two rails which cross each other in such a manner that a wheel rolling along either rail will have an unobstructed flangeway while passing the other rail. (Camp.)

Frog, n.—

See (1) Bolted frog.
(2) Center frog.
(3) Clamp frog.
(4) Crossing frog.
(5) Crotch frog.
(6) Movable point frog.
(7) Plate frog.
(8) Rigid frog.
(9) Solid center frog.
(10) Special frog.
(11) Spring rail frog.

Front, n.—The extreme end of a track under construction.

Frost plow, n.—A heavily constructed plow for breaking up frozen earth, used in winter grading work.

Frost spike, n.—A track spike longer than the ordinary spike, used in shimmed up track.

Fudge, v. t.—To put in a piece of work which is contrary to standard, but which is made to fit approximately and fulfill the required conditions.

Gage, n. (of track).—The distance between the heads of the rails measured at right angles thereto at a point ⅝-in. below the top of the rail.

Gage, n.—"Standard gage." The gage of 4 ft. 8½ ins.

Gage, n.

See (1) Clamp gage.
(2) Tie plate gage.
(3) Tight gage.
(4) Track gage.
(5) Wide gage.

Gage bearer, n.—A laborer who carries the clamp-gage ahead of the rail car.

Gage plate, n.—A "continuous plate." A slide plate extending clear across the tie, and provided with braces which rigidly hold the rails to gage.

Gauntlet track, n.—A track, one rail of which lies between two rails of a main track. It may leave the main track by a switch; a gauntlet track may lead off from a side track, the middle rail entering and leaving the center of the main track by use of frogs.

General foreman, n.—A foreman who has charge of all the work and laborers, on a construction job.

Grade, v. i.—To prepare the ground for the reception of the ballast and track.

Grade, n.—Ground which has been prepared to receive ballast and track.

Grade crossing, n.—A crossing in which both roads are at the same level or elevation.

Grade line, n.—The line on the profile representing the tops of embankments and bottoms of cuts ready to receive the ballast.

Grade stake, n.—A stake set with the top at the correct height for the track.

Gradient, n.—The rate of inclination of the grade-line from the horizontal.

Grading machine, n.—A large plow attached to a machine with endless apron carriers for excavating and throwing dirt onto a grade, or into dump wagons.

Grass line, n.—A defined line of vegetation on the shoulder of em-

bankment. The space between the grass line and the track is kept free from weeds and grass.

Gravel, n.—Small worn fragments of rock, coarser than sand, occurring in natural deposits.

Gravel train, n.—A train carrying gravel for ballast.

Gravity yard, n.—A yard in which the separation or classification of cars is aided by gravity. The movement of cars to yard tracks is accomplished by pushing the cars up to the top of a hump, where they are released and run down hill to the desired spot.

Green horn, n.—A man inexperienced in track work.

Grief, n.—Difficulties encountered and caustic criticisms from superior officers.

Ground switch stand, n.—Same as "jack knife switch stand." A simple lever stand, without target, the handle of which lays flat on the head blocks when the switch is closed.

Guinea, n.—A foreigner of any nationality.

Gumbo, n.—A term commonly used for a peculiarly tenacious clay, containing no sand.

H. B.—(Head block,) n.—Used interchangeably with P. S. to denote the position for the switch point.

Half round tie, n.—A slabbed tie having greater width on lower than on top face.

Hand out, n.—A lunch.

Hang, v. t.—To "hang angle bars." To place a pair of angle bars on the head end of a rail, when laying it in the track, bolting loosely with only one bolt.

Hardy, n.—A rail chisel. See track chisel.

Head, n.—"Head of rail." Same as "ball of rail."

Head block.—The two long ties to which the switch stand is spiked.

Head rod, n.—Same as "number one" rod. The switch rod nearest the point of switch.

Heart tie, n.—A tie showing sapwood on one or two corners only and which sapwood does not measure more than one inch on either corner, on lines drawn diagonally across the end of tie.

Heavy curve, n.—Same as "sharp curve." A curve which has a high degree of curvature.

Heel, n.—(1) The end of the rail being placed which will rest against the end of the rail previously laid; (2) The end of a switch rail; (3) The end of a frog farthest from the switch point; (4) Anything used as a fulcrum under a bar.

Heel block, n.—A casting used in the joint at the heel of the switch point.

Heel casting, n.—Same as "heel block."

Heel-in, v. t.—To "heel-in" a frog or switch point. To place the end of the frog or switch point against the end of a rail in the track, when putting in a switch.

Heel plate, n.—A plate used under the joint at the heel of the switch rail.

Heeler, n.—The man who, in laying track, gives the commands, and directs the placing of the heel of each rail in the angle bars.

Hewed tie, n.—A tie hewed on at least two sides.

High.—A command given to jack men when raising to indicate that the track has reached the required height.

High spiker, n.—A spiker who follows a spiking gang, and drives spikes down which have not been driven home.

High switch stand, n.—A switch stand with a high target, generally used for main line.

Hip Heeler, n.—The laborer who works next to the heeler.

Hobo, n.—An itinerant track laborer, who makes a practice of travelling around the country, working temporarily on extra gangs.

Hog head, n.—A locomotive engineer.

Hold, v. t.—"To hold a train." To stop a train or delay it.

Holding power, n.—The "holding power" of a tie. The resistance a tie offers to a spike to prevent spreading of the rails.

Home block signal, n.—A fixed signal at the entrance of a block, to control trains in entering and using said block.

House track, n.—(1) A track alongside or entering a freight house and used for cars receiving or delivering freight; (2) A track running alongside a freight house; (3) A track leading to an engine house.

Industry track, n.—A track leading to a factory or manufacturing plant.

Insulated joint, n.—A track joint designed to stop the flow of an electric circuit.

Interlocking machine, n.—The primary operating or controlling mechanism of an interlocking plant, placed in the interlocking station, and in which the interlocking feature is effected.

Interlocking plant, n.—An arrangement of switch, lock and signal appliances so interconnected or interlocked that one movement must succeed another in a predetermined order.

Intermediate switch, n.—A switch in a yard, not connecting directly with the ladder track, but leading off from a primary track which does connect with the ladder track. The intermediate switch points are located just behind the frog of the primary track.

Intermediate switch stand, n.—A stand whose target is at a height intermediate between a high and a low switch stand. Generally used in yards.

Iron, n.—Track rails.

Iron car, n.—A four wheeled car used in laying track, propelled by men or horses.

Jack, n.—A car without air brakes.

Jack, n.—"Track jack." An instrument used for raising track.

Jack knife switch stand, n.—Same as "ground stand."

Jerry, n.—An Irish track laborer.

Jim, v. t.—To spoil or render unfit for use.

Jimmed, adj.—Spoilt or injured.

Jim crow, n.—A rail bender, designed only to give a rail a kink or angle at one point.

Joint, n.

See (1) Bonded joint.
(2) Bridge joint.
(3) Broken joint.
(4) Compromise joint.
(5) Insulated joint.
(6) Mock joint.
(7) Offset joint.
(8) Square joints.
(11) Step joint.
(9) Supported joint.
(10) Suspended joint.
(12) Three tie joint.

Junction sign, n.—A warning sign placed a standard distance from a railway crossing or junction.

Junk line, n.—A railroad line containing old and poor material, and in poor running condition.

Key, n.—An iron pin which is placed through a hole in the end of a bolt, in order to hold the nut on. The pin is split, the two parts are spread after inserting in the hole, and the key is thus prevented from coming out.

Kill, v. t.—"To kill a track," To disconnect a track so that it cannot be used.

King-snipe, n.—A section foreman.

Kink, n.—A short piece of track, originally taught, which has moved out of line.

L. & S. angle bar, n.—Same as "long and short angle bar."

Ladder track, n.—A track connecting in series the body tracks of a yard.

Lagging, n.—Same as "sheathing." Boards braced against the sides of earthen ditches, etc., to prevent cave-ins.

Launch, v. t.—To slide. To move endways.

Lead, n.—(1) Distance from point of switch to point of frog. (2) A ladder track.

Lead track, n.—An extended track connecting either end of a yard with the main line.

Leary, n.—Same as "dumpy" or "push car."

Level, n.—The condition of the track in which the elevation of the rails transversely is equal.

Lift rails, n.—Rails which lay up against main line rails when a switch is thrown for side track; these rails gradually elevate the wheels until the flanges are carried up over the main line rails.

Line, n.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

Line, v. t.—(1) To line track. To put track in a desired, or the proper position. (2) To line up switches. To throw one or several switches so that a desired route is obtained.

Line, n.—(1) A railroad. (2) A route on a railroad.

Line bent.—"Line bent rail." A rail which has been bent laterally, and retains a permanent set.

Line man, n.—The man who stretches the tie line ahead of the tie spacers in a track laying gang.

Liner, n.—(1) A foreman engaged in lining track. The laborers are also frequently called liners. (2) Gage liner. The laborer who throws the rail into position for the gage spikers.

Lip, n.—A lateral projection of a rail end at a joint.

Live rail, n.—Same as running rail. The rails of a weighing scale on which cars are placed for weighing.

Loading track, n.—A track on which cars are placed to take on a load.

Lock-nut, n.—A nut so designed that when tightened it strongly resists loosening.

Long and short angle bar, n.—Same as L. & S. angle bar. An angle bar with a long punch on one end and a short punch on the other, to fit two differently drilled rails.

Long punch angle bar, n.—An angle bar with the maximum distance between punch holes, where a railway has several standard distances.

(To be Continued.)

Personals

A. S. Clopton, general foreman, has been appointed superintendent of bridges and buildings of the Missouri, Kansas & Texas, with office at Parsons, Kan. Mr. Clopton succeeds F. W. Bailey, resigned.

Porter Allen, assistant supervisor, Philadelphia division of the Pennsylvania R. R., has been appointed supervisor of division 15, Pittsburg division, with office at Uniontown, Pa., succeeding S. H. Kuhn, transferred. J. E. Zullinger has been appointed supervisor of division 14, with office at East Greensburg, Pa. Mr. Zullinger succeeds H. M. Grimm, transferred. W. E. Dunbar, assistant supervisor of the Northern Central, at York, Pa., has been appointed assistant supervisor of division No. 3, of the Philadelphia division of the Pennsylvania R. R., with office at Lancaster, succeeding Porter Allen, promoted, and C. M. Hursh, assistant supervsior of the Northern Central, at South Port, N. Y., has been appointed assistant supervisor of division No. 22, of the Tyrone division, with office at Osceola Mills, succeeding R. P. Koons, promoted. H. M. Grimm has been appointed assistant supervisor of the Northern Central, at York, Pa., succeeding Mr. Dunbar, and C. W. Barwis has been appointed assistant supervisor at South Port, N. Y., succeeding Mr. Hursh.

W. V. Betts, supervisor of division No. 1 of the Philadelphia, Baltimore & Washington, at Clayton, Del., has been appointed supervisor of subdivision No. 15, Buffalo & Allegheny Valley division of the Pennsylvania R. R., with office at Reynoldsville, Pa., succeeding M. C. Phalen, assigned to other duties.

E. E. Bradley has been appointed signal engineer of the Western Maryland, with office at Baltimore, Md.

G. A. Purdy has been appointed general foreman of bridges and buildings of the Missouri, Kansas & Texas, with office at Denison, Tex. O. O. Horton, general foreman of bridges and buildings, has been transferred from Denison to Smithville, Tex., succeeding J. L. McDonald, who has been appointed superintendent of bridges and buildings, with office at Denison. Mr. McDonald succeeds F. W. Bailey, resigned.

R. B. Seymour has resigned as chief engineer of the Chicago, Indiana & Southern and the Indiana Harbor Belt.

G. C. Cleveland, at Cleveland, O., has been put in charge of maintenance of way on the Chicago, Indiana & Southern.

A. C. Shields has been appointed division engineer of the Amarillo division of the Chicago, Rock Island & Pacific. This is a new office.

R. L. Holmes, assistant engineer of the Texas & Pacific at Dallas, Tex., has been appointed division engineer of the eastern division; office at Dallas.

J. W. Thompson has been appointed chief electrician of the Chicago & Alton, succeeding S. W. Dietrich, resigned. The office is at Bloomington, Ill.

F. J. Allen, resident engineer of the Missouri & North Arkansas, has been made engineer maintenance of way, his office remaining at Eureka Springs. The former position has been abolished.

J. C. Carleton has been appointed roadmaster of the Northern division of the Northern Ry. (Costa Rica), succeeding E. Landreau, resigned. The office is at Zent, Costa Rica.

W. B. Redgrave, division engineer of the Staten Island Rapid Transit and the Staten Island Ry., has been appointed engineer maintenance of way; office at St. George, Staten Island, N. Y.

H. E. Hale, principal assistant engineer of the Missouri Pacific, at St. Louis, Mo., has been appointed engineer maintenance of way, with office at Little Rock, Ark., succeeding E. J. Correll, resigned.

E. M. Weaver, signal engineer of the Long Island R. R., headquarters at Jamaica, N. Y., has been appointed engineer maintenance of way, succeeding J. B. Austin, Jr., transferred. The office of signal engineer has been abolished.

William C. Weldon has been appointed purchasing agent of the Colorado & Southern, with office at Denver, Colo.

John W. Kearney has been appointed manager of the new publicity department of the Missouri Pacific; office at St. Louis, Mo.

J. A. McFarland has been appointed chemist and engineer of tests for the St. Louis & San Francisco; office at St. Louis, Mo.

W. H. Fenley, of the Union Switch & Signal Co., and formerly signal engineer of the Chicago Great Western, has been appointed signal engineer of the Panama R. R.; headquarters at Colon, Canal Zone.

F. E. Phillips, formerly assistant chief engineer, has been appointed chief engineer of the Grand Junction & Grand River Valley, succeeding E. L. Mosely, who has resigned to accept a position with the Canadian Pacific.

G. W. Hegel has been promoted from principal assistant to chief engineer of the Chicago Junction, with office at Chicago.

The engineering department of the Spokane & Inland Empire has been moved to Portland, Ore., and is in charge of R. Budd, chief engineer of the Spokane, Portland & Seattle. A. M. Lupfer, formerly chief engineer, and J. B. Ingersoll, formerly chief electrician of the Spokane & Indland Empire have resigned.

RAILWAY CONSTRUCTION.

The Houston & Texas Central Co. has decided to build a cut-off, it is said, from Giddings, Tex., northeast via Caldwell to Stone City about 50 miles.

According to reports, the Oregon Short Line is planning to build an extension in Idaho to cover both sides of the valley between Idaho Falls and St. Anthony, both east and west of the present St. Anthony-Idaho Falls branch; in all, about 80 miles.

It has been announced by the Southern Pacific that the line of the recently incorporated Colusa & Hamilton will tap the main road at Harington, in Colusa county, between Arbuckle and Williams.

According to press reports, the Pacific Electric will build a line from Redlands, Cal., to Highland, five miles.

The Chicago, Anamosa & Northern, now operating 20 miles of steam line, has awarded the contract for an extention to Quasqueton to the L. E. Myers Construction Co., Chicago, Ill.

The Pecos Valley Southern, which operates a line from Pecos, Tex., south to Toyahvale, 41 miles, is planning to build an extension of about 45 miles, to Alpine, and ultimately south to Boquillas, on the Rio Grande border, about 90 miles additional.

The Oklahoma City Terminal Railway was organized August 7, $75,000 capital, to build a terminal on the proposed extension to Oklahoma City, Okla., of the Missouri, Oklahoma & Gulf.

The Malibu Tidewater has been incorporated at Los Angeles, with $800,000 capital, to build a line from Santa Monica to Oxnard, with a number of extensions. The company owns 15 miles of line, built several years ago, into the Rindge lands, to the north of Santa Monica, and as soon as the necessary right-of-way is secured the old roadbed is to be rebuilt and put in shape for th eoperation of heavy equipment.

Material is now being shipped to Santa Barbara, Cal., for the construction of the broad gage railroad connecting the Palmer Annex Company's proposed refinery at Cat Canyon

with the Southern Pacific at Guadalupe. The proposed line will be about 30 miles long.

Bids have been opened by the Long Island for the elimination of grade crossings and electrification work on the North Side division between Flushing, N. Y., and Port Washington.

The Chicago & Northwestern Ry. is to build a line into Mosinee, Wis., as a continuation of the branch line from Kelly to Rothschild.

The Stuttgart & Southern has been incorporated in Arkansas with $300,000 capital, to build from Stuttgart, Ark., south through Arkansas county to Bayou Meto, 25 miles. The incorporators include J. I. Porter, E. Tallman, J. L. Ingram and G. C. Lewis.

During the month of July the Santa Fe System appropriated the following amounts to cover cost of improvements: Widening banks, between mile posts 976 and 1101, Valley division, $171,000; purchasing tie plates, etc., for use on Western lines for balance of year, $260,000; ballasting track and widening banks to standard width, between mile posts 426 and 552, Plains division $267,000; making necessary track changes at Richmond, Cal., $23,000.

The Louisville & Nashville will reconstruct its entire yard at Milan, Tenn. Heavier rails will be installed.

The Brownell Improvement Co., 133 W. Washington St., Chicago, Ill., is understood to have been awarded the contract by the Pennsylvania R. R. for track elevation work at Cleveland, O., from E. 26th St. to Central Ave. The contract includes a considerable amount of masonry work and is said to total about $750,000.

The Detroit, Bay City & Western, which recently built a line from Bay City to Caro, filed an amendment to its articles of incorporation with the Secretary of State, Lansing, Mich., giving it authority to extend the line from Caro to Wilmet, both in Tuscola county. The road opens a county never touched by steam or electric roads.

It is reported that the Kansas City Southern Ry. has recently let contract for the construction of $500,000 worth of improvements on the road between Joplin and Kansas City. This is the last of the $4,000,000 of improvements on the above stretch of roadway. Twenty-seven miles of new track are being built, and forty-seven miles of changes in grading are being made. All the grading will be reduced to a one-half of one per cent grade when the work is complete. All work is specified to be completed by Jan. 1, 1912.

The San Diego & Arizona will shortly commence construction work on the continuation of its line into the Imperial Valley. The company has now invited bids for grading work for a short stretch from New River west.

The Phildelphia & Reading has under consideration the construction of a new line from a point near the town of Boyertown, Pa., to the Earl Ore Banks.

Grading work for the new line of the Ocala Northern from Orange Springs to Palatka has been about completed to the latter place. Tracklaying has been started at the Springs, and it is expected that this 20 miles of new line will be completed soon. At Palatka the Ocala Northern has acquired the old Georgia Southern & Florida Ry. terminals, with an abundance of yard room and storage tracking.

With The Manufacturers

New Literature

Hayes Track Appliance Co., of Richmond, Ind., has issued circular No. 64 illustrating the extensive use of Hayes derails on the Southern Pacific. The circular mentions the use of Hayes derails in connection with automatic block signals on the Harriman lines and illustrates some details of practice on this system.

* * *

The C. W. Hunt Co., 45 Broadway, New York, has issued catalogue No. 11-5, giving a description of the Hunt electric locomotive together with illustrations of plants, showing the locomotive in operation under varying conditions. These locomotives are designed for operation by storage battery or trolley, or for combination storage battery and trolley.

* * *

Hubbard & Co., Pittsburg, Pa., send out a very neatly bound and attractive catalogue of its line of track tools. A few pages in the front of the book are given over to illustrations and a description of the different steps in the process of manufacturing Hubbard track tools from solid steel. The remainder of the catalogue describes, with excellent illustrations, an extensive line of track tools.

* * *

Fairbanks-Morse & Co.'s general catalogue No. 60 contains descriptions of the exceedingly heavy line of tools, supplies and machinery manufactured by this concern. The book is bound very neatly in cloth and contains a large number of illustrations. The catalogue states that this company has a corps of competent engineers and their advice may be obtained in connection with the installation of machinery, insuring that proper consideration will be given the conditions under which the machinery is to be operated. The No. 26 Fairbanks-Morse section motor car is described in a special pamphlet, which shows three views illustrating the construction of the car.

* * *

R. Seelig & Son, Chicago, Ill., issue an illustrated catalogue with price list of engineering, surveying and mining instruments manufactured according to designs and patents owned by the company. In addition to describing their line of instruments the catalogue contains much valuable information on the construction, care, calibration and adjustment of surveying instruments. The construction of Seelig's patent wye level is diagramed, illustrated and described in detail in a special leaf pamphlet.

CRUCIBLE CAST-STEEL SHOVELS.

The Hussey-Binns Shovel Co. has a special process of manufacturing crucible cast-steel, plain-back shovels, the blade with socket and straps complete, from a single ingot of crucible cast-steel in one piece without welds or rivets and with a concentration of metal in the socket and base of strap. This produces a strong and durable type of shovel blade without excessive weight.

The crucible cast-steel ingot when rolled into the necessary shape and size not only has the advantages explained above but it is said has the hardest and toughest wearing surface possible to produce. The use of a special selection of the highest grade of Northern white ash handles especially made and selected for these shovels forms a combination of durable materials in an exceptionally strong system of construction.

The blade and straps being made in one piece without

welds or rivets avoids a serious source of weakness. The concentration of metal in the socket and base of straps in a manner exclusively used by this company increases the comparative strength and durability of its product. The weakness of some other one-piece plain-back shovels is lack of strength in socket and straps and the fact that they are not made of crucible cast-steel. Bessemer and open-hearth steel, it is claimed, even if of "crucible analysis" will not give the same economical results. Unfortunately many types of shovels of varying quality and durability, after being finished look so much alike that even the expert finds difficulty in selecting those most durable and economical in service. The character of the service in which shovels are used, the class of labor using them and many other conditions to which they are subjected make it very difficult to determine the actual values excepting by careful and thorough theoretical tests backed up by actual service. This often takes more than a year, according to the character of service and test. Hussey-Binns shovels, it is claimed, have actually shown an average of one shovel to three and a half of another make costing two-thirds the price. Wherever a test of this character has been carried through to completion and accurate records kept the saving in cost of tools used has not only been positively demonstrated, but the saving has been much more than was anticipated.

Many consider "a shovel a shovel." It is an expensive opinion. Considering the number of shovels used, though the cost of each is small, the total is large and a saving of even 10 to 15 per cent is well worth trying for. The shovels made as described are claimed to have reduced the cost of tools used for the same amount of work done from one-quarter to one-half and in some cases even more.

The Hussey-Binns Shovel Co., of Pittsburgh, Pa., which controls and exclusively uses this system, has factories located at Charleroi, Pa. This concern is said to be the only maker of crucible cast-steel for use exclusively in shovels, spades and scoops; 35 years successful operation and its special process and materials make its product unique.

CARBO STEEL POSTS AND POLES.

Year by year the cost of wood poles and wood posts is advancing and the necessity of a substitute is rapidly becoming more apparent to the user.

Wood poles or posts have been very unsatisfactory at their best, not only due to their short life, but to their cumbersomeness, thus entailing a high cost for handling with respect to hauling, freights and storage, and they have little or no scrap value. Any substitute for wood should therefore not only be so made that this cost of handling can be materially decreased, but if possible the cost of installation and maintenance should be much lower than that of wood.

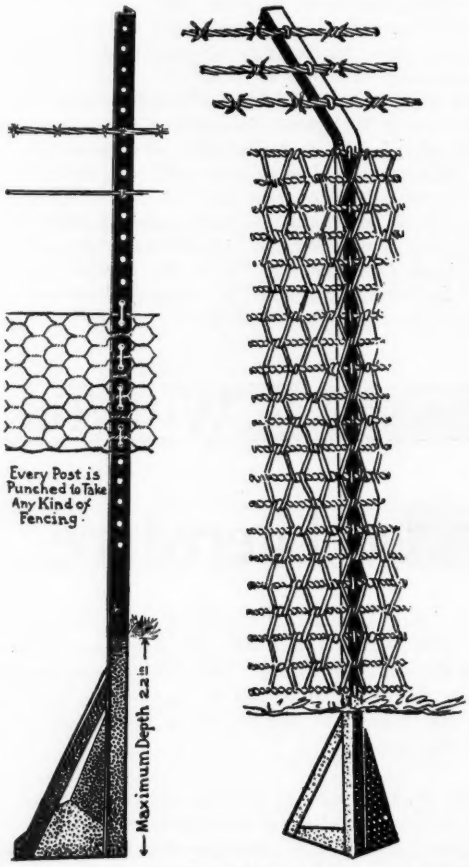
The reason for comparing a pole and post together is evident when you consider the fact that the forces at hand are practically of the same nature. The pole and post of the past has relied entirely on being strong enough to resist any forces from what might be termed a dead weight standpoint. In other words the pole or post had to be strong enough so that it would not give under any of the forces at hand.

The basic idea underlying the development of carbo-steel poles has been to utilize the element of elasticity, to cut down the unessential metal. In the patent carbo base, which is made of steel, the bottom plate fixes the point where the post or pole is held in the ground, or in other words the point of suspension. With all the dirt on top of this plate the post or pole cannot be pulled out of the ground when an extraordinary force goes against it, but it simply bends over and returns to its original position.

All the weight of the dirt in the hole is utilized to hold the carbo base in the ground, for which reason a less depth of hole is required, about two-thirds depth of the oridnary hole being sufficient. No concrete should be used in connection with the all-steel base inasmuch as the upright should be left free to move at the ground line. The carbo base also permits of the nesting of one post or pole within the other so that several times as many posts or poles can be placed in the same space as has been the case in the past with wooden poles.

In order to take fullest advantage of the quality of elasticity, a special high carbon is used which allows the posts or poles to bend without permanent set when an extraordinary force goes against them.

The right angle is preferred as the upright cross section inasmuch as it is the most economical cross section from an



Carbo Steel Post. Standard Straight and Non-Climable Type.

investment standpoint. The poles or posts are sold covered with a special asphaltic preparation. The post is standardized to use standard tools and punched to take any kind of fencing, using a standard staple to fasten the wire, so that it will not pull off.

It is interesting to note that the United States government used carbo steel posts for the boundary fencing between Mexico and the United States. Many of the larger western ranchers, institutions, etc., are utilizing the posts and light poles. They are also used with equal effectiveness for tree supports, trellises, hitching posts, mail boxes, sign posts, etc. A point which should especially appeal to every one is the fireproof features of all-steel posts or poles, which is absent in wood.

Carbo steel products are sold by the American Steel Post Co., with main sales office and factory at Los Angeles, and a branch manufacturing plant in Chicago.

BARTLEY NUT LOCKS FOR TRACK BOLTS.

Milton Bartley, president of the American Nut & Bolt Fastener Co., Pittsburgh, Pa., patented August 14, 1900, a nut and bolt fastener, which is manufactured by the abovementioned company. This company commenced the manufacture of these Bartley fasteners in the year 1901 and from that time up to the present writing has sold in the United States 100,000,000 and in foreign countries 40,000,000.

Mr. Bartley, a very progressive man, received a patent on improvements on nut locks from the United States government on January 17, 1911, and also has patent in all foreign countries on this same fastener. This fastener is for rails, frogs and crossings, especially.

Milton Bartley, Pres.
American Nut and Bolt Fastener Co.

The fastener is made from open-hearth steel, 60 carbon. Herewith is shown a facsimile of the device before it is applied. The merit of the fastener is that it is applied with a wrench in the same manner as is the spring styles, but an advantage over the spring fastener is that it has the whole bearing surface of the fastener against the splice bar and the nut. And when it is wrenched up to position for service the oval shaped locking arm projects 3/32 of an inch in front of the nut so it is impossible for it to be jarred off; but if you wish to remove the nut the wrench will force it over the oval projection, or it can be wrenched up if any wear occurs just the same as the spring styles and the oval projection always keeps the nut locked.

One of the illustrations shows the fastener as it is applied to 100 lb. rail. Mr. Bartley states that he had to turn down one order in July for 50,000 of these fasteners from the Union Railway and another order for 400,000 for the reason that he was not at that time in position to manufacture these fasteners. Since July he has sold his patents to the American Nut & Bolt Fastener Co., of which he is president, and this company is arranging to manufacture these fasteners at the rate of 100,000 per day and will be in a position in a few weeks to put this fastener on the market.

Bartley Nut Lock.

These fasteners have been under test on the Pennsylvania Lines West for the past fifteen months and, it is stated, are giving satisfaction; on the Pennsylvania Railroad, near Philadelphia, for the past ten months; on the Chicago, Milwaukee & St. Paul Railroad, near Seattle; also on the Pittsburgh & Lake Erie Railroad and the Baltimore & Ohio Railroad.

Bartley Nut Lock as Applied to Rail Joint.

Mr. Bartley has sold all his foreign patents to a Pittsburg syndicate, which will manufacture these fasteners in Canada in the near future.

INDUSTRIAL NOTES.

The Atchison, Topeka & Santa Fe Railway has had over 500 Gill Selectors in use in its telephone train dispatching circuits for several years past. In the extension of its dispatching circuits the company has now placed an order with the United States Electric Company of New York for 55 Gill Selector equipments of the local battery bell type, with dispatcher's calling outfits for the new circuits. The United States Electric Company states that a gratifying feature of its business is the number of repeat orders for extension of railroad service, due to the uniformly efficient and economical operation of the Gill equipment.

Harry W. Pickett, formerly with the Cincinnati Equipment Co., has established an office in the Harrison building, Philadelphia, Pa., where he will conduct the sales of railway supplies and equipment. He will handle locomotives for the Vulcan Iron Works, Wilkes-Barre, Pa.; dump cars for the Wm. J. Oliver Co., Knoxville, Tenn., and industrial locomotive cranes and relaying rails for the Geo. M. Newhall Engineering Co., Philadelphia, Pa.

The Orenstein-Arthur Koppel Co., of Pittsburgh, will put its new and enlarged plant in operation about September 1. It is located at Koppel, Pa., on the Pittsburgh & Lake Erie, and the Pittsburgh, Fort Wayne & Chicago.

Hiram Oldershaw, secretary of the Vulcan Iron Works, Chicago, died at his home in New Britain, Conn., on August 18, at the age of 65.

The Lehigh Coal & Navigation Co. has awarded a contract to Frank Heister and Owen B. Williams, Lansford, Pa., for driving a tunnel 11 ft. wide, 7½ ft. high from top of rail to roof, from Nesquahoning to Hauto, Pa., a distance of five miles.

Henry W. Swoyer of the Richmond plant of the American Locomotive Company, New York, has been made general manager of the Brooks plant of that company, succeeding W. A. Wheatley, resigned to go to the Canadian Locomotive Company, Kingston, Ont.

The American Car & Foundry Co., it is said will erect a $10,000,000 car plant at Gary, Ind.

Recent Engineering and Maintenance of Way Patents

PATENTS.

METHOD OF FORMING CONCRETE PILES.

999,431—Richard J. Beall, Jr., Washington, D. C.

A method of forming concrete piles consisting in driving in the ground a tube having an unobstructed longitudinal bore and an enlarged point closing the lower end of the tube and detachable therefrom forming an opening of greater diameter than the tube. The tube is withdrawn without the shoe, and the space above the shoe is filled with concrete deposited in the tube during the withdrawal of the same.

CONVEYOR FOR GRADING.

999,515—J. E. Murdock, Barnes Corner, N. Y.

An endless conveyor comprising a main frame, a drum and roller mounted in the frame, and a belt on the roller and drum. Scrapers are mounted on the belt, and there is a dirt receptacle extending transversely, being open at its top and one end.

RAILROAD SPIKE.

999,773—James S. Fox, Jackson, Mich.

A railroad spike, comprising a body portion having a head formed on one end and having two of its opposite faces inclined to provide a broad entering point at the rear of and on the opposite side of the axis of the spike from that on which the head is, the lower portion of the spike sloping to a portion of reduced width having vertical sides at the base and laterally projecting wings. The wings extend outward into the plane of the sides of the body of the spike and are adapted to engage the fibers of the tie to prevent the ready withdrawal of the spike.

REINFORCED CONCRETE CROSS TIE.

999,771—W. D. Forsyth, Youngstown, O.

A reinforced concrete tie consisting of a body of concrete wherein are embedded a U-shaped metallic reinforcement and rail fastening devices, each of the rail fastening devices consisting of a flanged sleeve embedded in the concrete forming the body of the tie and adapted to receive and retain a non-metallic, resilient bushing which in turn is adapted to receive and retain an adjustable metallic sleeve.

RAIL SUPPORT.

1,000,329—Wm. P. Day, assignor to the International Steel Tie Co., Cleveland, O.

A rail support embodying spaced beams and cross bars connecting the beams together in spaced relation to each other, the cross bars being arranged in pairs at the ends of the beams. Concrete filling is used in the spaces between the cross bars of each pair and the adjoining portion of the beams, and pillow blocks are embedded in the concrete.

SIGNALING SYSTEM FOR RAILWAYS.

1,000,402—H. W. Griffin, assignor to the Union Switch & Signal Co., Swissville, Pa.

In a railway signaling system, the combination of a block section, a track circuit for the block section, a railway signal located at each end of the block section for governing the passage of cars or trains in opposite directions through the block section, and a signal circuit for each signal. Each signal circuit is controlled by the track circuit, and circuit controllers, one operated by each signal and included in the circuit for the signal at the opposite end of the block section.

RAILWAY CROSSING.

1,000,590—J. B. Dunlap, Tulsa, Okla.

This railway crossing consists of bent corner rails, a pair of slidable rail sections disposed between the rails of each track, and means for sliding either pair of rail sections to bridge the gap between the opposite corner rails, thereby providing a continuous crossing.

SUPPORTING AND PROTECTING DEVICE FOR THIRD RAILS.

1,000,679—Geo. S. Inman, Chicago, Ill.

A combined protecting and supporting casing for an inverted third rail comprising laterally arranged sections of reinforced concrete which are adapted to be fitted over the rail and are provided with longitudinally arranged grooves or recesses at their meeting edges which are adapted to be filled with a binding material to bind and seal the sections.

DOUBLE DERAIL APPLIANCE.

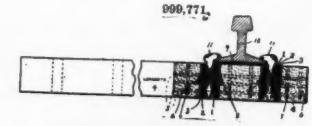
1,000,680—L. J. Kieffer, Bowling Green, Ky.

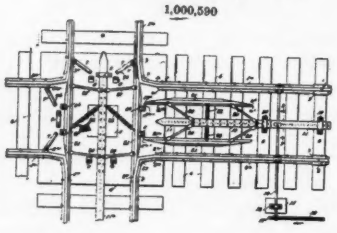
The combination with a main track and a co-operating siding, of a derail for each track, the derailers being adapted to move simultaneously one into operative position and the other into inoperative position and vice versa.

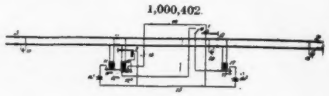
RAIL TIE AND BRACE.

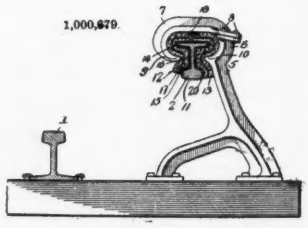
1,000,780—Joseph Chambers, Jr., Hillman, Me.

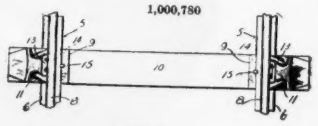
This device consists of a plate having a brace-block extending upwardly, the inner face of which conforms to the rail below the ball; a lug forming an integral part of the brace-block and contacting with the ball of the rail the block having a bearing portion extending beyond the rail bearing portion of the plate; an inclined spike forming an integral part of the plate adjacent to the outer end and beyond the brace-block, and additional spikes also forming a part of the plate and arranged perpendicular to it.

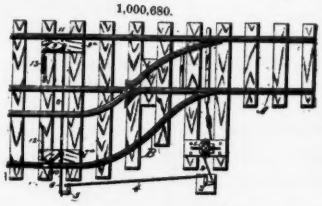


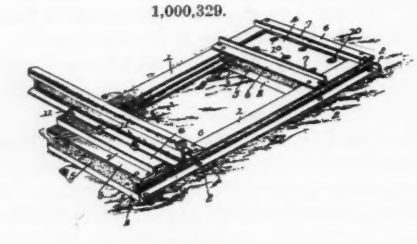


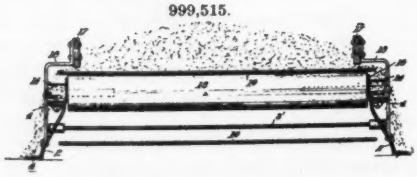












The Illinois Central is said to have ordered 9,450 tons of rails.

The New York Central & Hudson River has placed an order for 5,000 tons of structural steel with the American Bridge Company, and 1,500 tons of structural steel from the Buffalo Structural Steel Company.

The Boston & Maine is asking prices on 5,000 tons of bridge material.

The Missouri Pacific it is reported has let a contract to the Yirginia Bridge & Iron Co. for 3,040 tons of deck girder spans for bridge work.

The Great Northern has purchased 700 tons of culvert pipe from the United States Cast Iron & Pipe Foundry Co.